



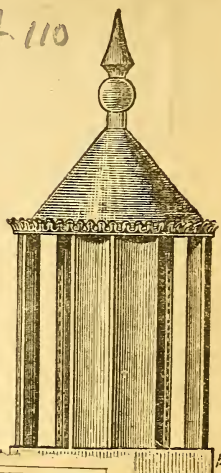
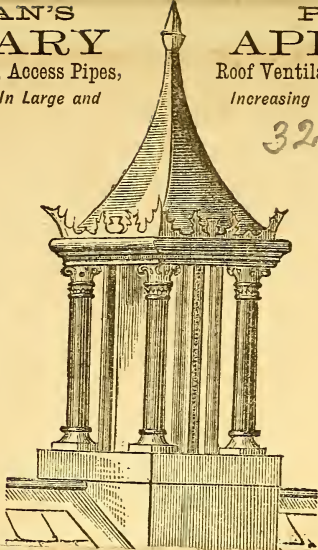
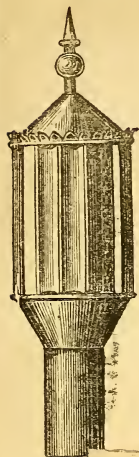
HEALTH LECTURES

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Scottish Provident Institution.

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THIS SOCIETY differs in its principles from other Offices. Instead of charging rates higher than are necessary, and returning the excess in the shape of periodical Bonuses, it gives from the first as large an Assurance as the Premiums will with safety bear—reserving the Whole Surplus for those Members who have lived to secure the Common Fund from loss.

A Policy for £1200 to £1250 may thus at most ages be had for the Premium usually charged for (with Profits) £1000 only; while, by *reserving* the surplus, large additions have been given—and may be expected—on the Policies of those who participate.

The NEW ASSURANCES have in each of the last seven years exceeded a **Million**. The RECEIPTS in last year were **£566,444**. The cost of management was only 9.4 per cent. on Premiums, and 6.5 per cent. on the Income.

THE FUNDS (increased in 1880 by £283,922) now exceed **FOUR MILLIONS**.

While 46th in point of age, the INSTITUTION is now 5th in amount of Funds.

EXAMPLES OF PREMIUMS FOR ASSURANCE OF £100 AT DEATH.
WITH PROFITS.

Age.	Payable during Life.	Limited to 21 Payments.	Age.	Payable during Life.	Limited to 21 Payments.
25	£1 18 0	£2 12 6	40	£2 14 9	£3 7 5†
30	2 1 6*	2 15 4	45	3 5 9	3 17 6
35	2 6 10	3 0 2	50	4 1 7	4 12 1

* Thus, a person of 30 may secure £1000 at death by a yearly payment, *during life*, of £20, 15s. This Premium would generally elsewhere secure £800 only, instead of £1000. Or he may secure the same sum of £1000 by *twenty-one* yearly payments of £27, 13s. 4d., being thus free of payment after age 50.

† At age 40 the Premium, *ceasing at age 60* is, for £1000, £33, 14s. 2d., being about the same as most Offices require to be paid during the whole term of life.

THE FIFTH SEPTENNIAL INVESTIGATION.

showed a **Surplus** of £624,473, of which a third (£208,150) was reserved for after division, and £416,323 divided among 6662 Policies entitled to participate. Policies of £1000 sharing a first time were increased to sums varying from £1180 to £1300 or more. Other Policies have been raised to £1400, £1500 and upwards. A few of the early Policies have been doubled.

Report with Statements of Principles may be had on application.

EDINBURGH, Dec. 1881.

JAMES WATSON, Manager.

LONDON OFFICE—17 KING WILLIAM STREET, E.C.

Scottish Widows' Fund

Life Assurance Society.

Accumulated Funds, £7,000,000. Annual Revenue, £1,000,000.

THE ACCUMULATED FUNDS and other PROPERTY of this Society belong exclusively to the Members, in whose interest the business is conducted, with the primary object of dealing equitably with all concerned. Every suggested improvement in Life Assurance is considered, and when ascertained to be of general advantage is adopted, with the result that although established when Assurance Contracts were surrounded by restrictions, no Office at the present time offers more liberal conditions.

The Claims paid at Death exceed Twelve Millions Sterling.

1. The Surrender Values allowed by the Society, and the amounts of the "Paid up Policies," or Policies free from premium payments, given in lieu of such values, are not arbitrary proportions of premiums paid, or of the sums assured, but each is the result of separate valuation, in which the circumstances of the assurance to be surrendered and the relation in which it stands to the other assurance are taken into account, and the interests of the retiring and continuing Members are equitably adjusted.

EXAMPLES OF SURRENDER VALUES OF POLICIES OF £1000 as at 31st Dec. last (1880) in relation to premium paid; and also of the amount of "Paid-up Policy" allowed in lieu of a cash value:—

without expense to the borrower, except where the title to the policy has become complicated and legal assistance is necessary.

III. The whole Profits realized are divided among the Members in the form of additions to the sum assured, which, when vested, can be surrendered for present value in cash, or applied to reduce or extinguish premiums.

EXAMPLES of the effect of BONUS ADDITIONS ON POLICIES of £100, in force at 31st December 1880 taken at 35, as the average age at entry.

Such of the following sums as become claims before December 1887 will be increased by £1:9s. per cent, for each annual premium paid between 31st December 1880 and that date. Additions marked are contingent on the lives assured surviving five years after date of assurance.

Age at Entry, Premium, &c.	Duration of Policy.	Amount of Premiums paid.	Surrender Value in Cash.	Percentage of Value to Premium.	Amount of Paid-up Policy.
		£ s. d.	£ s. d.		£
Policy issued at Age 35,	1 yr.	29 1 8	9 12 5	33 p. ct.	25
at annual	5 "	145 8 4	84 4 0	58 "	185
premium of	10 "	290 16 8	184 12 0	63 "	375
£29:1:8.	15 "	436 5 0	293 1 5	68 "	555
	20 "	581 13 4	419 0 0	72 "	710
	30 "	872 10 0	743 16 8	85 "	1070

It will be observed that assurances with this Society bear a surrender value from the outset; that the proportion between such values and the premiums paid increases rapidly with the endurance of the assurance; and that, except in the case of the newly effected assurances, the "Paid-up Policy" exceeds in amount the premiums paid.

II. Loans are granted on Security of Policies for amounts nearly equal to their surrender values,

TO SUCH EQUITABLE ADMINISTRATION OF THE SOCIETY'S AFFAIRS

is mainly to be attributed its general acceptance with the public, whose preference is marked by the New Business annually effected with it throughout the United Kingdom having long largely exceeded in number and amount that effected with any other Life Office in the same time and field. The NEW ASSURANCES of last Septennium amounted to nearly NINE MILLIONS Sterling.

Policies in force amount to over Twenty-Five Millions.

HEAD OFFICE: 9 ST ANDREW SQUARE, EDINBURGH.

A. H. TURNBULL, *Manager.*

J. J. P. ANDERSON, *Secretary.*

Year of Entry.	Total Sum payable Dec. 1880.	Year of Entry.	Total Sum payable Dec. 1880.	Year of Entry.	Total Sum payable Dec. 1880.
	£ s. d.		£ s. d.		£ s. d.
1824	2548 14 10	1854	1508 11 7	1870	1197 9 8
1831	2309 3 11	1858	1413 5 1	1872	1158 3 0
1838	2026 18 9	1862	1334 6 9	1874	1119 0 0
1845	1767 8 8	1864	1303 1 11	1876	1085 0 0
1847	1702 19 7	1866	1272 0 9	1878	1051 0 0
1852	1561 0 5	1868	1236 7 1	1880	1017 0 0

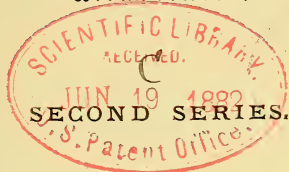
IV. Premiums paid can never be wholly Forfeited. Notices are given of each premium falling due, and other steps are taken to prevent the lapsing of assurances, and to have such as lapse revived. When a lapsed assurance is not revived, and no application is made for its value, the amount is passed to the credit of the retiring member, and intimation sent to him.

Edinburgh Health Society.

HEALTH LECTURES

FOR THE PEOPLE.

Illustrated.



*DELIVERED IN EDINBURGH DURING
THE WINTER OF 1881-82.*

Vol. 653.

Edinburgh:
MACNIVEN AND WALLACE.

1882.

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CONTENTS.

SOME LESSONS FROM MODERN MEDICINE,	PAGE 1
By J. A. Russell, M.B., F.R.S.E.	
THE HUMAN BODY,	23
By D. J. Cunningham, M.D., F.R.S.E.	
PARASITES IN THEIR RELATION TO FOOD AND HEALTH,	55
By Andrew Wilson, Ph.D., F.R.S.E., F.L.S., &c.	
THE BRAIN AND ITS FUNCTIONS,	81
By J. Batty Tuke, M.D.	
THE SKIN AND ITS MANAGEMENT IN HEALTH,	107
By W. Allan Jamieson, M.D.	
HOW WE DIGEST OUR FOOD,	129
By James Foulis, M.D., F.R.C.P.	
SMALL-POX AND VACCINATION,	159
By D. Rutherford Haldane, M.D., <i>P.R.C.P.</i>	
A COLD : WHAT IT MEANS ; ITS POSSIBLE CONSEQUENCES ; AND HOW IT IS TO BE AVOIDED,	181
By James O. Affleck, M.D., F.R.C.P.E.	

EDINBURGH HEALTH SOCIETY.

INSTITUTED 1881.

PRESIDENT.

THE RIGHT HON. THE EARL OF ROSEBERY.

THIS SOCIETY has been formed :—

To promote, *by all means in its power*, attention to personal and domestic Cleanliness, to Comfort, Self-denial, Temperance, and the Laws of Health generally.

The Means to be employed for this end may, in the opinion of the Committee, be stated in the meantime as follows :—

1. The delivery of Popular Lectures bearing on the subjects in question by Physicians and other qualified persons.
2. The printing and distribution of these Lectures, and of small Leaflets.
3. Providing subjects of Interest for the Mind, and encouraging proper Amusements and Physical Exercises.
4. Giving assistance to the Constituted Authorities in the promotion of sanitary improvements by drawing their special attention to any particular insanitary condition.
5. Obtaining the assistance, so far as necessary, of any other Society in the City willing to co-operate in the work of this Society.
6. Arranging for the *re-delivery* of the Society's Lectures in villages in the neighbourhood of Edinburgh, and for the formation in such places of small *local* Committees in connection with the Society.

Members Enrolled and Subscriptions Received by :—

The Honorary Treasurer—ROBERT COX, Esq., Gorgie.

The Honorary Secretary—WALTER A. SMITH, Esq., 24 Hartington Place, Viewforth.

Messrs MACNIVEN & WALLACE, Publishers, 144 Princes Street.

Annual Subscription, **ONE SHILLING**, or more.

Life Subscription, **ONE GUINEA**.

PREFACE.

IN publishing this volume of Lectures, delivered in connection with the Edinburgh Health Society, the Committee of Management think it will be interesting to the Public to refer to the work which has been done during this, the first session of the Society. In the first place, this work has consisted in the delivery of the lectures now printed. These lectures were listened to by large and attentive audiences, numbering on an average two thousand, and the Committee feel sure that many important hints were given in them, and they trust that these hints will be made use of by those who heard them, and also by many more who may now read them. The Committee and the Lecturers have been much gratified with the very large numbers of the working classes who have attended the lectures, as evincing the interest taken in them by those for whose benefit they were chiefly intended; and they have also been pleased with the orderly behaviour and the great courtesy which has been shown on all occasions, without exception, to them, to the Chairmen, and to all connected with the Society.

The second work carried on by the Society, principally through the Committee, has been to make arrangements for the redelivery of these lectures in some of the smaller towns in the outskirts of Edinburgh, showing that the interest in this Society is not confined to Edinburgh, but is extending outside of it. It may perhaps interest some to know that an application has been received from Iceland to have the lectures sent there in order that they may be translated into the language of that country and made useful to the inhabitants.

The third work done has been to consider and discuss many important questions in connection with health and sanitation. In regard to some of these questions, it was decided that it was better not to interfere, and in regard to others, information is still being sought. The Committee wish it to be understood, that the object of the Health Society is not to come into collision with the authorities, but rather to co-operate with them. It does not wish to embarrass or to force legislation; neither do its members wish to make themselves disagreeable in any way. All they want to do, is to educate the public to observe and work for themselves; and the Committee hope, that in time, it will not be necessary for the Society to go to the Public, but that the Public will come to the Society and ask them to assist them in connection with many important health matters.

With reference to the financial condition of the Society,

the Committee are glad to say that, so far, the money obtained has been sufficient to meet all the current expenses. The Committee desire it to be distinctly understood, however, that the Lecturers have not only given their services *free*, but that many of them have most kindly been at considerable outlay in providing illustrations for their lectures. The expenses have been only in connection with the hall, and in paying for advertising and printing. Up to this time, 207 members have joined the Society. Considering the large audiences who have benefitted by the Lectures, the Committee consider this number rather disappointing, and they trust that it will soon be largely increased. It entirely depends upon the support given, not only of money but of influence, what amount of good the Society can do. The Society is very anxious to do a great deal. It is very anxious, for instance, to provide proper means of Amusement for the People, such as a suitable Gymnasium, so that young men and women, when the weather is wet and the days are short, can go to an airy hall and practise Physical Exercises and have other innocent amusements, which are so essential to their general health. But this cannot be done without additional funds, obtained from a much larger Roll of Members. It is therefore hoped that all will help the Health Society, not only with their money but with their interest, and such help will be a great spur to the Committee to continue their labours in promoting the health and happiness of their fellow citizens.

In conclusion, the Committee cannot omit to give their sincere thanks, in the name of the Health Society, to those distinguished gentlemen who have so kindly and so successfully delivered, without thought of remuneration, the lectures during this session. These gentlemen must have the pleasing satisfaction of knowing that they have done much to assist the objects of the Society and to promote the well-being of the community.

SOME LESSONS FROM MODERN MEDICINE.

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By J. A. RUSSELL, M.B., F.R.S.E.  
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DR J. A. RUSSELL, in treating of "Some Lessons from Modern Medicine," said:—The wonderful progress of the arts and sciences in modern times has often been said and sung, but it is not generally known that in none of them has greater improvement been recently made than in that art which affects us all so closely, because it deals with our very persons. Not only is this the case as regards ground already gained, but at this moment the science of medicine more than any other is rich in promise of benefit to mankind in the near future. That this should fail to arrest attention is not wonderful. The way to attract the admiration of the multitude is to cause human misery, not to cure it; to slay men in thousands. not to save them. Alexander, and not Hippocrates, is called the Great: Napoleon the First, and not the inventor of chloroforming, is the Hero. Moreover, discoveries in medicine often require technical knowledge to understand them, or they apply merely to sick people; or, what appeals still less to the imagination in healthy persons, they merely show how to ward off disease from those who feel no present ill.

There are indeed those who deny that any discoveries are made, or any progress gained. These are persons who do not believe in science, but believe in themselves, and who usually unite extreme credulity to scepticism. Because medical art cannot meet all demands upon it, and honestly acknowledges the fact, they dub the science conjectural, and, refusing credence to whatever is demonstrable, plain, and reasonable, put the blindest faith in whatever is mysterious and unknown. Such was Madame de Sévigné, who, never wearied of uttering sarcasms on the inanity

of medicine, at the same time inundated her friends with a mass of absurd remedies ; and many now resemble her in this who want her wit.

Putting aside for the present the gains by sanitary science, and advances in the principles of medicine, let us call before us a single advance in the details. Twenty years ago the operation of ovariectomy could only be attempted at the risk of a criminal prosecution for performing an operation so dangerous as to be unjustifiable. Patients suffering from the disease which this operation cures had then the prospect of inevitable death in about two years. To-day it is one of the safest operations known to medical art, and one surgeon is able to boast that he has added upwards of ten thousand years to the sum of the lives of his patients.

If we ask how the knowledge of these bounteous gifts of medical science to civilised man has been attained, we find that it comes mainly from three sources. We have *firstly* the advance in chemistry and other branches of physical science, and the invention of instruments such as thermometers and microscopes to aid and enlarge the powers of our senses ; or of instruments contrived to take direct records of fact, which are independent of the fallacies incident to the use of our own senses.

The discovery of chloroform was due to pure chemical research, though its anæsthetic properties were afterwards ascertained and applied by Sir James Simpson. Let Sir James draw the lesson in his own words :—"It is perhaps not unworthy of remark, that when Soubeiran, Liebig, and Dumas engaged, a few years back, in those inquiries and experiments by which the formation and composition of chloroform was first discovered, their sole and only object was the investigation of a point in philosophical chemistry. They laboured for the pure love and extension of knowledge. They had no idea that the substance to which they called the attention of their chemical brethren could or would be turned to any *practical* purpose, or that it possessed any physiological or therapeutic effects upon the animal economy. I mention this to show, that the *cui bono* argument against philosophical investigations, on the ground that there may be at first no apparent

practical benefit to be derived from them, has been amply refuted in this, as it has been in many other instances." Surely no one in this audience who has undergone a surgical operation in blessed unconsciousness, or still less any one who has endured the pain chloroform could defy, will ever again say, "where's the use," or cast ridicule on those who strive to add to our scientific knowledge without having an immediate practical end in view.

Not only do we now possess an array of drugs unknown forty years ago, which put additional powers within our reach ; but the intimate action of the old drugs, whether upon muscle or nerve, heart or brain, has been so elucidated that they are used in quite a new way, and so promising is the outlook that Professor Huxley says, "It will, in short, become possible to introduce into the economy a molecular mechanism which, like a very cunningly contrived torpedo, shall find its way to some particular group of living elements, and cause an explosion among them, leaving the rest untouched." I fear that this desirable torpedo will not be discovered in Edinburgh, for the Secretary of State has recently refused a license to our Professor of Materia Medica to perform a few experiments on frogs and rabbits with a drug from Borneo where it is used to anoint the arrows of the natives. The operation for which leave was refused is identical with that performed by nurses every day, when medicines are administered subcutaneously with the aid of a syringe and hollow needle. For aught we know this drug may possess some property that would relieve some one near and dear to us from suffering and sickness, and save us from anxiety and grief ; but the man, whom we in Edinburgh have set apart as specially competent to make enquiry for us, is arrested through the action of a small body of zealots, who insist that their zeal, though not according to knowledge, shall be testified in *our* unabated pains and recorded in *our* losses.

The invention of instruments for observation has had much to do with alterations in medical treatment, by giving such clear indications, that the physician can avoid doing wrong, even if he does not know how to do right. As an example of change of practice, I may mention that in the year 1833 one of the London Hospitals used 48,900 leeches, while last year it used only 250.

Statistics.—The second source of medical knowledge that I would mention is Statistics, which are now applied to the investigation of innumerable problems and have been fruitful of important information in the most unexpected quarters. They render great service in testing opinions. Opinions differ from facts in that they lie in the nebulous region between the known and the unknown. They form too unstable a foundation for the erection of any weighty system of practice, but when tested and found to rest on the firm rock of fact another step forward can be taken.

Twenty years ago no one knew of the association between pulmonary consumption and a damp subsoil, but statistics have fully proved the connection. In fifteen English towns recorded by Mr Simon the deaths from consumption fell immediately when the subsoil was dried by a system of drainage. In Salisbury the deaths from consumption fell 49 per cent.; in Ely, 47 per cent.; and Merthyr Tydvil, which gained least, had its death rate from consumption lowered by 11 per cent. By statistics we were pointed to the high mortality from consumption in the British army, and especially in the Guards, due to confined air—a mortality which has been so affected by better ventilation of barracks that the consumptive death rate fell in the Guards from 125 in 10,000 in the year 1858 to 16·9 in the year 1875, that is to say, the deaths from consumption alone in the Guards in 1875 were less than a seventh of the number in 1858. By statistics we learn that drapers die at a rate of 108, compared with 76 of grocers, and we also learn that this excess of deaths, in a class of men who live as a rule under similar social conditions to the grocers, is due to asthma and other pulmonary complaints, and are thereby pointed to the cause in close, ill-ventilated shops, having an atmosphere laden with fluff and dust, and windows and doors blocked with goods. The grocer, on the other hand, owes his favourable position on the scale of mortality to an active trade carried on in an open, well ventilated shop, with the door usually wide open. By this same method we can trace the effect of each different trade and profession upon health and longevity, and are brought to face such questions as, why hairdressers should have a mortality half as great again as that of the agricultural labourer, or why publicans should die almost

as rapidly as cabmen, and at just twice the rate of the clergy. The answers to such questions deserve our careful study, for they point out the direction in which improvement is required, and whether the reform is of that small class which can be accomplished by the summary method of legislation, or whether it requires a change in social habits, or alterations in the conditions of living and working. We can not only compare one trade with another, but can discover the influence of race and its associated customs in the exceptional longevity of the Jews all over the country. The influence of social customs among ourselves can be examined in the same way, and when we find that total abstainers live longer than other classes of the community, we are prepared to believe that they are self-selected—in part at least—by their native vigour of constitution, and that they can eat more and probably work more than non-abstainers.

We may almost say that through statistics we can prophesy the future, for such is the regularity of nature, and so unvarying are her operations under similar conditions, that though nothing is more uncertain than the time of death of any single individual, yet nothing is less liable to vary than the age at which each thousand of 100,000 children born in any year will have passed away, and so much do varying circumstances tend to balance each other, that the number of accidents on the London streets may be very closely predicted for any day.

This is what renders LIFE ASSURANCE possible, and has done so much for the promotion of thrift, and social improvement of the middle classes of society. The same boon is now offered to the wage earning classes through the post-office and assurance companies, with schemes for insuring against death or sickness specially adapted to their circumstances.

In the prospectus of a new company—the Scottish Life Assurance Company, Limited—which has instituted a thrift department as a specialty, I see that at age twenty-one £100 with profits may be insured for 3s. 4d. per month, or £50 with profits for 1s. 8d., a sum which will not keep the pipe of an ordinary smoker alight for the same period. The practice of life insurance is to be commended for its moral consequences as well as on other grounds. It aids virtue and increases self-respect, by giving the

assurance, that not death itself can prevent the discharge of those obligations to our families and society, to which we are in honour bound. It is well then that any doubts respecting the foundations of insurance can be quenched in the cool clear waters of scientific certainty. The intention of insurance being to render us independent of the uncertainty of life and provide a fixed sum at death by contributions to a common fund, it is plain that those who die early contribute least to the fund, and that the long lived are in a sense the financial losers by the arrangement, for they have to make good to the fund the sum beyond their contributions carried off by those who die before they attain the average age for which the premium is calculated. If each person could foretell the time of his death there would be no insurance, for the long-lived would refuse to join purses with the short lived; and even now, stringent precautions are taken to exclude this class, who will find it increasingly difficult to get insured, as medical science advances, and is more and more able to predict the future.

PREVENTIVE MEDICINE.—Let us now turn to the statistics, without which preventive medicine could not exist, and let us see what this branch of medicine, which teaches that it is easier to *keep* out of illness than to *get* out of it, has been able to do for the health of the country.

We find in the Registrar General's returns for England and Wales that the death-rate for—

1841-51 was 22.33.	1861-71 was 22.50.
1851-61 „ 22.25.	1871-81 „ 21.27.

So that here is a very marked fall in the last ten years. From these figures, it is seen that during the thirty years from 1841 to 1871, the death-rate did not increase, though all over the country a rapid change in the distribution of the population was taking place—a change, the natural consequence of which is greatly to increase the death-rate. The country population is nearly stationary in number; while the rapid growth is altogether in urban districts. In Scotland, during the last ten years, the larger towns increased 37.37 per cent. in population; while the Mainland rural districts only increased 2.81 per cent.; and the population of the

Insular rural—the healthiest districts of all—actually diminished in number by 1·3 per cent.

In England and Wales it is not so easy to define what is town and what is country ; but, at the late census, the proportion of persons living in places which, for one reason or another, were considered to be of sufficient importance to exercise urban powers, to persons living elsewhere was 212 to 100 ; or, if we reckon as rural all places with populations under 3000, the proportion of dwellers in towns is 66·6, and in country 33·4, and on this basis the estimate of town population would be in 1861, 165 dwellers in town, to 100 in country. At the census of 1871, the number had risen to 184, and in 1881 had reached 199 ; so that this year, the number of dwellers in towns is almost exactly double the number of dwellers in the country.

Now, if there is one fact more than another which the Registrars-General, both in England and Scotland, delight to din into our ears, and to illustrate and prove in every report, it is that, just as the density of the population increases so does the death-rate—that, in fact, the nearer people live to each other, the shorter their lives are. They show that where the density is 166 persons to the square mile, the death-rate is 17 per thousand, where it is 1,718, the death-rate is 25, and where the population is 12,357 per square mile, the death-rate is 38 per thousand. The Registrars-General are so impressed with this fact that they delight to turn it over and present it to us in all kinds of different aspects. Sometimes they arrange us by the acre, as you would see in Dr Smart's lecture last year on Preventible Diseases. Sometimes they imagine us spread separately over the ground, and they measure our distance from each other in each district, and call it our proximity in yards, but always with an unvarying result—a higher death-rate accompanies proximity to each other, and the nearer to each other in yards we are, or the more of us there are upon an acre, the higher the death-rate. Thus it is shown that in 53 districts, where the proximity is 147 yards, the mean duration of life is 51 years. In 345 districts, where the proximity is 39 yards, the mean duration of life is 45 years. In 137 districts, where the proximity is 97 yards, the mean duration of life is 40 years. In 47 districts, where the proximity is

46 yards, the mean duration of life is 35 years. In the Manchester district, where the proximity is 17 yards, the mean duration of life is only 29 years. And in Liverpool, where the proximity is 7 yards, the mean duration of life is only 26 years. Has then sanitary science accomplished nothing between 1841 and 1871, when, in the face of such a law and the growing aggregation of people into towns, it has prevented the death-rate from rising?

It has done more than this, for if we examine the statistics of the last decade, 1871-81, when sanitary measures have begun to bear fruit, we find that the death-rate has fallen about $4\frac{1}{2}$ per cent. in England and Wales, viz., from 22·5 to 21·27; while the lower death-rate of this decade, says the Registrar-General, "implies the survival of 299,385 persons, who, with the previous rate of mortality, would have died." A report states that—"if twelve cases of serious, but non-fatal illness, be reckoned for every death, it follows that about three million persons, or over *one ninth* of the whole population have been saved from a sick bed by some influences at work in the past decade, which had not been in operation previously." Of this reduction, which is "only an instalment of sanitary progress," more than three quarters is due to a fall in the deaths by the seven zymotic diseases, from 4·14 per cent. to 3·36 per cent. Those diseases "are the most influenced by sanitary improvements, and the most easily controlled by sanitary authorities." "And of this three quarters, just half or three eighths of the entire reduction is in fever—the disease which, more than any other, shows itself in connection with such faults of drainage, of water supply, and of filth accumulation, as it is within the province of good sanitary administration to remove. The fever death-rate has fallen steadily from 80 per 10,000 in 1870 to 32 in 1880.

EDINBURGH. — Looking nearer home, I find from a table kindly given me by Dr Littlejohn, that if the ten years, 1870 to 1879, be divided into two periods of five years, there is a fall in the death-rate from 22·88 in the first quinquennium to 20·82 in the second, and that the whole of this gain is due to a fall in the zymotic rate from 4·59 to 2·43. This, though a gratifying tribute to the usefulness of our Health Department, shows

that the conditions which produce our mortality otherwise are not affected, and a death-rate even of 21 per thousand in a city like Edinburgh, not crowded by a poor industrial population, challenges the serious consideration of her citizens. The Registrar-General in his last detailed report gives our mean annual mortality as higher than that of Aberdeen, Leith, or Perth, and it becomes us therefore to inquire, what can be done to counteract the operation of the law of density. That the inhabitants do not much fear the operation of this law, is to be inferred from the stipulations as to new streets and buildings, inserted by them in their local Police Act of 1879. While in London no street may be less than forty feet wide, exclusive of any gardens, open areas, fore-courts, or other spaces in front of the houses ; in Edinburgh the minimum width of a new street is only twenty feet, and moreover the width is to be measured from the houses or buildings. In London the height of a house must not exceed the width of the street. In Edinburgh the house may be once and one-half times as high as the width of the street. With such regulations as it possesses, and the very great number of public commons surrounding it, London may continue to grow in size, but not in density of population, and will continue to be the healthiest large city in the world. The contrast between Edinburgh and London in these respects seems fitted to excite some anxiety for our future, and may well call for such interest in the public health, on the part of the citizens, as shall influence municipal action. In health, as in other matters, the citizens must look to their own interests, and they cannot expect that the Medical Officer and Health Committee either will, or can, march on in advance unsupported by public opinion. Those in an official position, unless supported by the public, will always feel weak when enforcing health acts upon persons whose self-interest is opposed to healthy surroundings for others.

But some one will ask, in what way does density kill us ? and I answer, mainly by inducing three great causes of preventible mortality :—*First*, ZYMOTIC DISEASES, which smite chiefly the juvenile population from birth to puberty, and are as a class associated with filth. *Second*, PULMONARY COMPLAINTS, such as consumption that chiefly prey upon early adult life, and are

largely associated with confined air. And *Third*, DISEASES OF THE ORGANS of the body which mostly attack those in middle age, and are associated with intemperance.

Then, can the action of this law of density be suspended or modified? Not in ordinary conditions; but exceptional discipline, unlimited wealth, and energetic sanitary action can modify the law. The true cure for the law is that given by Dr Farr, who says—"It is certain the most effective means of reducing mortality is to thin the dwellings of the denser parts of the population, to abolish all rookeries, and not to rebuild them." In prisons the death-rate is low, very low, but there discipline is paramount. In the Peabody Model Lodging-houses, London, the death-rate is alleged to be only 16·7 per thousand for the last 16 years, while that of crowded neighbouring districts is 30 to 40; but the class who inhabit them is higher in the social scale than was intended, and the trustees began with half-a-million sterling, and now have £720,000. The effect of energetic sanitary action is seen in the reduction of the Glasgow death-rate to a point, still high, but far below that fixed by the law of density. The credit of this improvement is greatly due to the Hon. Lord-Provost Ure, who, aided by a distinguished medical philosopher, as adviser, has saved more lives than any other man in Scotland.

If we are to depend solely upon sanitary action to countervail the operation of the law of density, we shall be like a ship that puts to sea with a leak, and whose safety depends upon unremitting pumping. And who are those chiefly interested in keeping the pumps going? Undoubtedly those struggling to maintain a respectable and honest independence, to whom the loss of time and means which is involved by illness, or by having to support broken-down neighbours by rates or charity, threatens a breakdown for themselves, and loss of their position and self-respect. This class, then, so helpless individually, should pay special attention to the way in which their health is treated by the Local Authority.

I shall be told that if I attack density I trench upon the rights of property. Now, I would be most careful of rights of property. There is no property to which a man has a better

right than to his own health ; and wherever alterations or operations are proposed, that would infringe upon this, which is every man's property and the poor man's sole capital, is it not fitting that these alterations should be controlled by sanitary legislation ? The rights of property of some men when examined turn out to be wrongs to the property of others. It seems fair in most cases that landlords' existing rights of property in towns should only be touched by improvement schemes that give compensation. But has any man a right of *new* to crowd buildings upon the ground to such an extent as to shut out light and air, and give him double feu-duty, at the expense of the health of the residents ? Is not the additional feu-duty that is derived from buildings erected in addition to those allowed by Sanitary Science, so much money taken out of the pockets of the community, and an injury to the property of others ? Am I not injured, if, to give excessive feu-duty to a landlord, my neighbour is so crowded as to fall sick ? Am I not injured when I am deprived of his services ? Am I not injured when I support him in the Infirmary ? Am I not injured when I support him in the Poorhouse ? Am I not injured when I support his sons in Reformatories and Prisons ? And am I not injured when his daughters, instead of being a source of purity and strength to the community, become a cause of weakness and decay ? Let us have the allowable density of buildings fixed by enactment at a standard compatible with health, and then a "fair rent" is found by competition.

COMPENSATION.—But is compensation not required and due ? I say, wherever it is due, by all means let it be paid ; but first make sure by whom it is due. To illustrate this, I shall quote from a paper by Dr. Russell of Glasgow upon a case where compensation was demanded, consequent upon alterations ordered by the sheriff to correspondingly improve the ventilation of a building, in which the population had been trebled by subdividing it into single-room dwellings. These alterations spoiled six apartments renting altogether at £27. Dr Russell says :—

"Much emphasis was laid by the respondent upon the fact that the destruction of those six single apartments was a loss of rental amounting to £27 per annum, the houses being let at £4, 10s. each. This was designated an unwarrantable "confis-

cation of property," and "compensation" was insisted upon. It was asserted by architects that the consequent improvement on the property fully balanced this apparent loss, and that it must even be recompensed by a larger rental for healthier houses. But, let us take the loss of £27 per annum as an absolute loss, what is this in view of the enormous death-rate and propagation of sickness, evidently begotten of conditions which the sacrifice of this sum is intended to remove or mitigate? This mortality and accompanying loss of health and working-time on the part of the adult working population, prevailing through a period of years, represents a sum of money taken out of the pockets of householders and of rate-payers, and for whose sole advantage? If there is to be any discussion of 'compensation,' it must evidently be in the way of compensating the public." "The rental of those houses, let in excess of the number consistent with conditions of public health and safety, ought to be a charge against the property on the principle of higher premium of insurance required against a hazardous risk." But I shall be told, those houses were taxed upon their rental for sanitary purposes, and therefore contributed their fair share to the expenditure of the community on this behalf. Let us take the rental of these thirty-nine single apartments at £5 a-piece and of these six double apartments at £8. This gives an assessable rental of £243, say £240. Being under £10 in each case, the assessment for sanitary purposes amounts to 20s. at 1d. per pound, and for hospitals under the Public Health Act, to the large sum of half-a-crown, at one-eighth of a penny per pound. This is a contribution of £1, 2s. 6d. per annum or £9 in the eight years. Of that not a penny is paid by the owner. During that time twenty-three cases of infectious disease were removed to the sanitary hospitals, and treated at the public expense. For keep, treatment, and share of rent-charges, up-keep of buildings, &c., &c., £5 is a moderate estimate of the cost of each of these cases. This amounts to £115 for this item alone! Besides, there is the expenditure for maintaining a staff of men to form a cordon of inspection and observation from day to day around such properties. It would be well that the ratepayers should remember those figures in the face of demands for 'compensation' and *ad miseri-*

cordiam appeals made by the respondents in this and similar cases. The fact is that every such property is a sort of running sore upon the body of the community, diverting its substance from healthy uses, and draining the life-blood of the public. There is scarcely a fraction of the sanitary assessment drawn from the west end of Glasgow, or the shops in Buchanan Street, expended directly upon the west end or in Buchanan Street. It is spent upon the miserable properties which are the plague spots of the city, in a vain endeavour to keep down their disease and death-producing effects, the owners meanwhile pocketing the rents nett, so far as sanitary assessment is concerned, and crying out, 'confiscation,' 'compensation,' the moment an attempt is made to reduce this expenditure by operating upon its causes."

Rent.—Apart from political pressure, private individuals can do something to exempt themselves from the law of density. They can take the best house their means will afford. And here I earnestly commend the Glasgow health lecture, "The House," for its practical advice, and its clear statement of the moral and physical consequences of deficient house room. Workmen have often complained to me of the high rents and comparatively small number of houses suited for working men in Edinburgh. They complain that the rent of a large house may be only 4 per cent. upon its value, and yet 10 per cent. upon value may be charged for low-class property. But what is the reason of this? Is it not the difficulty and trouble of collecting small rents, the risk that some of them may not be forthcoming or of moonlight flittings, and the tremendous dilapidation caused by reckless tenants? Is it not the case that the wealthy tenant causes little damage, and will often repair it himself rather than trouble his landlord, while the rough and ignorant poor tenants smash and spoil and choke whatever can be injured? If the erection of workmen's houses paid even 5 per cent. without trouble, would there not be a rush of capital to build them? This is just an instance of the good being punished by high rents for the faults of the bad. The only way in which the working classes can have cheap houses seems to be for them generally to do as many of them have already done, and buy their houses for themselves. With the aid of the investment companies, in which Edinburgh abounds, this can be accom

plished. All that these companies require is that the applicant shall produce such a sum as may prove that he is in earnest, and secure them from loss. Of course, where boys marry at twenty-one, or earlier, as soon as they have escaped from their apprenticeship, it cannot be expected that they can do anything of this kind. But I fail to see why they need marry until they prove their respect for their intended wives and their intention not to depend upon charity in every little calamity, by doing something towards providing a home.

Opposition.—Ere passing on from the head of Vital Statistics, we may profitably ask how they were received when first introduced. The first bill for taking a census was introduced into Parliament in 1753, but defeated by such language as the following:—Mr Thornton, member for the city of York, said—"I did not believe that there was any set of men, or indeed any individual of the human species, so presumptuous and so abandoned as to make the proposal we have just heard." And Mr Matthew Ridley, member for Newcastle-on-Tyne, said—"The people looked upon the proposal as ominous and feared lest some public misfortune or an epidemical distemper should follow the numbering." These gentlemen belonged to a class which is active at the present day, and which although opposed to progress, has advanced so far as to form a number of Societies recognisable by the prefix Anti to their names—as Anti-vaccination, Anti-vivisection. The members of the sect of Anti-.s are eminently respectable; many of them are philanthropic and pious; all of them are unreasonable and opposed to progress. The sect has always shown a remarkable tendency to wrest Scripture. Their formula, which they apply to every advance in knowledge, is this—First, It is not true; Secondly, It is contrary to religion; and, thirdly, It is not new, or we knew it all before. Such a venerable sect deserves a history, but time will only permit me to go back to the year 1600, when we find the sect embracing several cardinals, and in such high power that, through the Inquisition, it pronounced sentence upon Galileo, the astronomer and inventor of the telescope. Part of the sentence runs as follows:—"To maintain that the sun is placed immovable in the centre of the world, is an opinion absurd in itself, false in philosophy and formally heretical,

because it is expressly contrary to the Scriptures ; to maintain that the earth is not placed in the centre of the world, that it is not immovable, and that it has even a daily motion of rotation, is also an absurd proposition, false in philosophy, and at least erroneous in point of faith," It will be instructive just now to consider the terms of Galileo's reply to this, in his letter to the Grand Duchess of Tuscany. He says : — "I am inclined to believe that the intention of the sacred Scriptures is to give mankind the information necessary for their salvation, and which, surpassing all human knowledge, can by no other means be accredited than by the mouth of the Holy Spirit. But I do not hold it necessary to believe that the same God who has endowed us with senses, with speech, and with intellect, intended that we should neglect the use of these, and seek by other means for knowledge which they are sufficient to procure us ; especially in a science like astronomy, of which so little notice is taken in the Scriptures that none of the planets, except the sun and moon, and once or twice only Venus, under the name of Lucifer, are so much as named there. This, therefore, being granted, I think that in the discussion of natural problems we ought not to begin at the authority of texts of Scripture, but at sensible experiments and necessary demonstrations ; for from the Divine word sacred Scripture and nature did both alike proceed, and I conceive that, concerning natural effects, that which either sensible experience sets before our eyes, or necessary demonstrations prove unto us, ought not upon any account to be called in question, much less condemned upon the testimony of Scripture texts, which may under their words couch senses seemingly contrary thereto."

The sect of Anti...s has attacked every step forward in physical science ; but its choicest comminations have always been devoted to improvements in medicine. Of course such a venerable and respectable sect included some doctors, so that many of the attacks have come from within the profession. Before the method of tying vessels with ligatures was invented, the only method in use for arresting bleeding in amputations was the barbarous one of searing the stump with a red-hot iron, or of plunging the limb into boiling pitch. When Paré in-

roduced his method of tying bleeding vessels with ligatures it was received with the bitterest abuse. From that time the next important appearance of the sect was made in connection with the introduction of the practice of vaccination. An anti-vaccine society was forthwith formed to protest against "a gross violation of religion, morality, law, and humanity." "The projects of these vaccinators," it was said, "seem to bid bold defiance to heaven itself—even to the will of God."

Sir James Simpson said—"Every proposed improvement seems to be met with the same invariable array of objections and arguments. The discovery may be new, but the grounds of opposition to it are not new, they are merely the old forms of doubt and difficulty and prejudice used on former occasions recalled and reproduced anew." This sect came to the front more at the time of the invention and application of chloroform and of anæsthetics generally than at any other time. Within the medical profession itself many men were exercised about the abolition of pain, and putting patients to sleep. The clergy became involved in the contest, from bishops downwards, and especially when Sir James Simpson proposed the use of chloroform in midwifery; and objections were so many and so varied that I verily believe Sir James Simpson showed more cleverness in combating the Scriptural and other objections than he did in introducing chloroform. Take a characteristic example. Dr P. of Liverpool said:—"I became increasingly aware that I must trench upon what might really appear to be exclusively the province of the Divine, but in which, nevertheless, in our own professional standing, and in the standing of baptized men, as opposed to heathens, we must assuredly have our place, and that a most important one." "What right have we, even as men, to say to our brother man, 'sacrifice thy manhood, let go thy hold upon that noble capacity of thought and reason, with which thy God hath endowed thee and become a trembling coward before the presence of mere bodily pain. What right still less have we as baptised men—men having a Redeemer, and gifted with the Holy Spirit to be our Comforter—what right have we, ungratefully or unbelievingly, to forget all this and be willing to go under the deep stupor of a power, the influences of which and connected with which, we know so exceedingly little?" It

is perhaps not wonderful that he should go wrong in his theology ; but when he comes to medicine he is just as bad. He says :—“ Besides, we have as yet no time to watch *other* consequences ; but one, I fear, in particular will become more common—I mean insanity ; I wish I may be mistaken, but I greatly fear it.” The same people who, in the early days of the application of anæsthetics in midwifery, insisted upon the “ propriety ” and the “ desirability ” of pain, and who demanded that the accoucheur should take upon himself the function of executioner of the curse denounced in Genesis chap. iii. ver. 16, “ in sorrow thou shalt bring forth children,” now-a-days revile and decry any one who endeavours to learn how to save men and women from suffering by inflicting the most trivial pain upon a frog.

Experiments.—The *third* great cause of advancement of medicine to which I intend to allude is experiments upon animals. These are either made on a large commercial scale upon men, or on a very small scale for precise scientific ends upon the lower animals. Since 1873 sixty-seven grave experiments of the former kind were made upon the population with infected milk ; that, in fact, putting on one side commercial experiments with water, with infected clothing, and with infected dwellings, we had sixty-seven epidemics from infected milk alone. In the commercial experiments with typhoid fever poison in milk, 3500 persons were involved, and in the commercial experiments with scarlet fever poison 800 persons were involved, and in diphtheria poison 500. In the fifty epidemics of typhoid, twenty-two were due to “ washing the cans,” or what milkmen call washing the cans, with foul water. The year 1873 is not so far back, and we need not find it difficult to appreciate these figures. It is important that you should be aware that the means of controlling these fevers are at the present day crowding upon us through experiments upon animals, especially through the experiments of a distinguished Frenchman, Monsieur Pasteur, who has added enormously to our knowledge and to our resources. He has been able to cultivate out of the body the poisons which cause certain diseases, and he has shown that in one of the fevers which we call splenic fever, and which affects man and animals alike, the poison is a vegetable of a very low form of organization. Dalton, the chemist and inventor of the

Atomic Theory, said he could never think of the atoms without thinking of them as penny pieces. In the same way we may think of these organisms as beans with stalk and seed, and this will help us to realise that the effect of these organisms, and the development of the disease depend partly upon whether we have been infected by the plant or by the seed. This explains, also, how it is that sometimes the infecting power is fugitive, while at other times it puzzles us with its long-continued infective properties. The plant is very easily killed, but the seed is very enduring and possesses great vitality. Cold will kill a plant, but cold will not kill a seed.

Pasteur has also investigated a disease called Fowl-cholera. It has nothing whatever to do with cholera, and only resembles it in that it kills fowls very rapidly. He has discovered that this disease is due to a low organism, which can be cultivated, and grows very rapidly in chicken soup. He took a vessel of chicken soup, and dropped into it a drop of infected blood about the size of a pin's head, and he found that it soon infected the whole bowl. Presently a change took place in the soup, the organism could be seen under the microscope, and the infected chicken soup was now a virulent poison for fowls. But not only so, M. Pasteur observed that you can pass on the infection from one bowl of soup to another by merely putting a drop of the infected soup into the new and fresh fluid, and so on to a thousand bowls it might be ; and that if you take a drop from the last of them and, having scratched a fowl, inoculated it with the fluid, it will take the disease and die. These experiments were repeated until there could be no doubt as to their accuracy. This is the stage which was reached last year when Dr Smart gave his lecture. But M. Pasteur has gone far beyond that within the last twelve months.

He can now produce a modified splenic fever, or a modified cholera of fowls. That is to say, by a suitable cultivation of these organisms, he can so change the properties of the plants that, when a fowl is inoculated, it shall take the disease in an easy way, and shall not die. But, more than that, the effect of the modified disease is as good as if the fowl had taken the disease in its severe form, so far as preventing its recurrence is

concerned. And he has managed in this way to inoculate the fowls with a tamed virus which confers a protective influence and yet ensures that the fowl shall recover. Of his methods of doing this I shall not speak further than to say, that one of the agents which M. Pasteur used in taming the virus is oxygen, and this seems to point to one way in which fresh air may influence the poisons of specific diseases. Indeed, Mons. Pasteur can so tame the organism that it will no longer give rise to any disease at all, and he has discovered where to stop short in the cultivating or taming process, so that he shall get the protective influence of the disease without killing the fowl. This process has been applied by him on a large scale in the treatment of the splenic fever which devastates whole herds of oxen and flocks of sheep on the Continent. In the course of his experiments he inoculated twenty-five sheep with the cultivated virus, and other twenty-five with the virus which had not gone through the cultivating process. The result was that the whole of the twenty-five that were so treated with the uncultivated virus died within fifty hours, whilst of the twenty-five inoculated with the cultivated virus not one died, and yet they were found afterwards to be insusceptible of taking this disease. Whenever this was made public, there was, of course, a rush of the farmers all over France to get their cattle inoculated, and the cattle are now being inoculated in thousands every day. So that here we have a remarkable instance of the experiments on animals benefitting the animals themselves in the first instance. M. Pasteur has followed up these researches with the most admirable ingenuity. Thus he has found that the spores of anthrax may last for over twelve years, and that oxen may take the infection from them through grazing over ground where previously other oxen had been buried, and where the spores of the disease had been brought up to the surface from the depths of the ground by worms. This discovery is rather interesting to English people on account of its association with Mr Darwin's last book, where he showed the curious office that is performed by worms in carrying up deeper portions of the soil to the surface. And here we find the same explanation in France found applicable to the coming up of the poison of diseased animals to the surface to infect the living. Of course, this points out the

lesson that the only effectual way of destroying these bodies is by cremation.

I may say that our practical light at present as to the means of preventing the spread of infectious diseases is as follows—to *avoid filth and to isolate disease*. That comprises the whole practice of the matter. How are we to isolate disease? I may be asked. In Edinburgh the Corporation has recently provided a fever hospital for that purpose, but it is most disappointing to find how little interest the public take in such a step forward, and how little they seem to care about it. We have in this hospital at present the means of affording the poorer classes a ready escape from the dangers of treating these infectious diseases at home. An instance recently came under my notice that shows these dangers. One of the children in a family took scarlet fever. The parents were urged to send off the child to the fever hospital for the sake of protecting the other members of the family and other inhabitants of the common stair. They declined to do so, because as they said the other members of the family had had it already, and therefore they supposed there was no danger to their household, and, as for their neighbours, they might take care of themselves. Now, all their neighbours—wonderful to relate—escaped. But another of their own children took the fever a second time very slightly and died of the secondary effects before an ordinary case would have recovered from the fever. I hope we will have this hospital so arranged as not only to afford this protection from danger to the poorer classes, but also so arranged as to give adequate accommodation for all classes of society. I hope to see wards fitted up so that any of the wealthier citizens may have two or three rooms to which they may bring the sick person, and any member of the family who wishes to nurse him. The patient might be treated by their own medical attendant, with the aid of the house surgeon, who is kept by the town, which would also provide skilled nursing. Here we can provide accommodation, which they could use in an emergency; and they would be saved both the expense and the trouble of making arrangements at home, which are the more difficult to make because of their ignorance as to what should be done. Of course, they would be expected to pay something for these

privileges, and I have no doubt they will be quite willing to do so.

Then, besides having an hospital to which we can carry off a sick person, we also have in this building room for a reception house and refuge for those who are in danger of taking disease from having been in contact with the sick. When a disease of this sort breaks out in a poor family, the proper mode of action, I conceive, would be to capture the whole family, to put the sick member in the fever ward, and to take the others into the reception house, and to watch them, letting them go to their daily work from that house, until we see that there is no risk of their taking the disease, and until we get their own house thoroughly disinfected. When infectious disease breaks out in the house of a wealthy citizen, what happens? Is it not this, that the whole of the children who have not the disease run for their lives to the nearest friend or to a hotel? That being the case, might it not be well to afford them accommodation suitable to their position in this reception house, for which, of course, they would have to pay? But they would have to pay far less for it than they do in a hotel, where the owner would naturally be very chary of receiving them, and if he did receive them, would make them pay accordingly. Now, that something of this sort is very desirable you will at once recognise, when I tell you that last year upwards of 3000 cases of infectious disease were reported to our medical officer of health. There were very nearly 2000 cases of scarlet fever reported in Edinburgh last year, and our accommodation in the Infirmary is for only 74 cases, unless when the disease breaks out to a very large extent, and the corporation steps in and provides fuller accommodation.

It is, I think, perhaps rather an unfortunate circumstance that the infirmary should have anything to do with our fever-house arrangements. The infirmary is a charitable institution, whilst the fever-house is not. We ask the citizens to come to it not in charity to themselves, but as a charity to the rest of the community. And the expenses of this accommodation they have already met by paying their rates, so that we may look upon it as a kind of insurance society to which every person pays, and which is, therefore, open and available to all. And another

reason why I think it is a mistake that the infirmary should have to do with these arrangements is this, that those people—and I hope there are not many of them—who shirk their duty and refuse to subscribe to the funds of the Royal Infirmary, in this way get out of their statutory obligation, for the Legislature throws upon every community the expense of the treatment of infectious diseases. If we all contributed to the funds of the Royal Infirmary, it would not matter very much to us whether the treatment was given by that institution or by the Local Authority. But why should those of us who subscribe to the Royal Infirmary be saddled with the expense of the treatment of infectious disease, which is laid by statute upon the rate-payers in general, and others escape without contributing anything for this purpose? I have been told more than once that some people in Edinburgh subscribed to *build* the Royal Infirmary on the distinct understanding that it would, by receiving fever patients, relieve them from their fever rates; in other words, that they paid some of their rates in advance and called it charity, thereby stealing the credit of giving a subscription. Now, I believe, that this is a slander upon the citizens of Edinburgh, who have amply proved that they are unsurpassed in readiness to contribute to public and charitable objects.

THE HUMAN BODY

By D. J. CUNNINGHAM, M.D., F.R.S.E.

“What a piece of work is a man ! How noble in reason ! how infinite in faculties ! in form and moving how express and admirable ! in action how like an angel ! in apprehension how like a god ! the beauty of the world ! the paragon of animals !”—HAMLET, Act ii., Scene ii.

I FEAR that it is an utter impossibility for me in the space of an hour and a quarter, and within the limits of a single lecture, to give you even a general sketch of the structure of the Human Body. Of all the subjects chosen for this session's series of Health Lectures, that which has fallen to my lot is the widest. The utmost that I can hope to do is to call your attention to some of the more important and interesting points in our bodily mechanism. I cannot waste a single word upon introductory platitudes.

When we are set to examine a piece of machinery, our first and most natural question is : For what is it adapted ? what kind of work has it to perform ? Having learned this, we are in a much better position to understand the parts of the machine, and the manner in which they are related. Thus when we know that a watch is for the purpose of recording time by the regular movements of the hands on the dial, we can appreciate in a much more intelligent manner the arrangement of the main-spring, wheels, and balances which produce the revolution of the hands.

Viewing, therefore, the human body in the light of a machine, let us first enquire what kind of work it does, or, in other words, what functions it performs.

A little reflection will render it apparent to you that we each possess the power of (1) *motion* and *locomotion* ; (2) *nutrition*, i.e.,

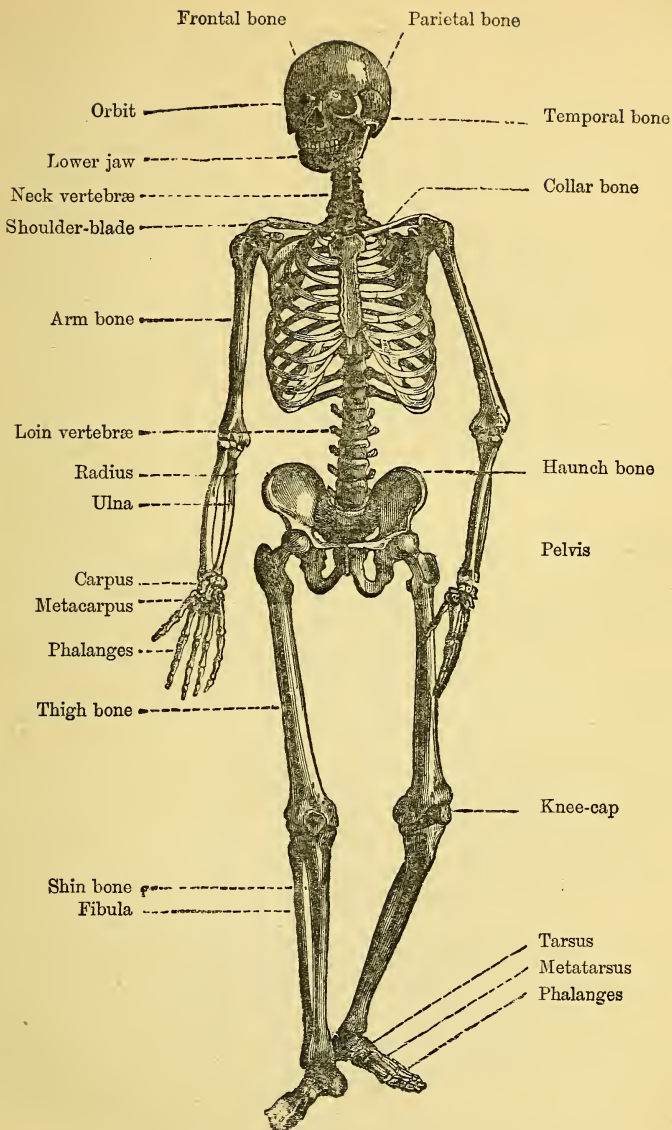
we eat, drink, breathe, perspire, &c., &c. ; (3) *innervation*, or the faculty by which we are brought into relation with external objects ; (4) *reproduction*, or the means by which the race is perpetuated.

If we descend to the very lowest stage of the animal kingdom and examine the *amoeba*—a very low form of life indeed—we find that it is capable of performing, in some degree at least, all these functions. Imagine a minute drop of the white of an egg, and you have in your mind a tolerably exact model of such an animal. It has little or no structure, and yet by contractions of its body it can move about in a liquid medium. Particles of food sink into its substance very much in the same manner as you would push a marble into a mass of putty—any part of its surface serving the purpose of a mouth. In its interior the nutritious parts of the food are extracted and diffused through the mass, whilst the non-nutritious parts are ejected—any point serving the purpose of a vent. Further, this simple organism has some appreciation of external objects ; and lastly, it can reproduce its kind by dividing itself into two or more new individuals, each as vigorous as the original.

As we ascend the ladder, the animals we meet lose this simple condition of body. A principle is at work by which the labour the organism has to undergo becomes divided ; coincident with this the organism becomes more complicated. By this I mean that each function seizes, as it were, upon a part of the body and adapts it to its own ends. Thus in the higher vertebrate animals we find a skeleton, joints, and muscles subservient to the function of *motion* and *locomotion* ; an alimentary canal, glandular apparatus, circulatory system, lungs, and many other parts devoted to the function of *nutrition* ; a nervous system for *innervation* ; and special parts for *reproduction*.

Man is one of these higher animals, and the pre-eminence which he claims over other animals is in great part due to the superiority of his nervous system—to the more perfect manner in which he is able to carry on the great function of innervation.

SKELETON.—Here we are then ; each of us possessed of a body ; each of us capable of carrying this body about with us ; and each able to move its various parts the one upon the other. Let us



study the means by which this is performed. This leads me, in the first place, to speak of the skeleton.

The skeleton is the bony framework or scaffolding which supports the soft parts of the body. Entering into its composition, there are about 210 separate bones in the adult. In addition to these the framework is completed at various points by plates and bars of cartilage or gristle.

In our study of the skeleton we classify the bones into three great groups, viz. : (1) those belonging to the trunk ; (2) those which form the head or skull ; and (3) those of the limbs.

The bony scaffolding of the TRUNK consists of (1) the spine or back-bone, (2) the ribs, and (3) the breast-bone.

Spine or Back-bone.—The back-bone is the great central pillar of the body. On its summit is poised the skull ; below it transmits the weight of the body to the lower limbs ; whilst laterally it bears the bones of the chest, which in turn support the bones of the upper limbs.

In the *child* the spine is composed of thirty-three separate bones, called *vertebræ*, placed one on the top of the other, but as life advances the lower nine segments amalgamate so to form two bones. In the *adult* therefore we find only twenty-six separate pieces entering into the formation of the spine.

If we take any one of these *vertebræ* we notice that it consists essentially of a solid cylindrical portion, called the *body*, in front, with a bony arch attached to it behind. The two together constitute a ring large enough to admit the first joint of the forefinger. Next look at the *vertebræ* in position. The bodies are all superimposed the one on the top of the other so as to form a column, whilst the arches also lie in series so as to constitute a canal. In this canal is placed the spinal marrow carefully protected round and round.

The *vertebræ* are arranged in groups. The first *seven* belong to the *neck*, and it is an interesting fact that in all mammals (with only three exceptions*) the number of neck *vertebræ* is seven. It matters not whether we examine the lengthy neck of the giraffe, or the short stunted neck of a pig or a whale ; it is always seven—neither more nor less.

* The three-toed sloth, Hoffman's sloth, and the manatee.

The succeeding *twelve* vertebrae bear the ribs and constitute the *dorsal group*, and the *five* following are the *loin vertebrae*. The next *five* vertebrae are welded together into a large triangular bone termed the sacrum, which fits in between the haunch-bones. It is through this bone, therefore, that the weight of the trunk is transmitted to the lower limbs.

It is a popular belief that man has no tail. This is quite a mistake. The sacrum is succeeded by four rudimentary vertebrae usually welded together. These constitute the human tail; but instead of projecting externally, as is customary in the majority of other animals, our caudal appendage is curved forwards in such a manner that we can assume the sitting posture without suffering any inconvenience from it.* The anthropoid apes resemble man in the rudimentary condition of the tail.

But you ask; How are these separate factors of the spine held together? The principal agents in effecting this are a series of tough, elastic, cartilaginous discs interposed between the solid bodies of the vertebrae, and to which the bodies are firmly adherent. They unite the vertebrae in such a manner that whilst the mobility between any two adjacent vertebrae is very slight, the column as a whole possesses great suppleness and flexibility. It can be bent in any direction, and can even be twisted upon itself, as is exemplified every time we look backwards when in the sitting posture.

Have you ever reflected upon what characteristic the high dignity of the body of man depends as compared with that of the lower animals? A little thought will make you see that it is his *erect attitude*. The anthropoid apes, it is true to a certain extent, approach him in this respect, but how shambling, crouching, and half-bent is their gait in comparison with his. The

* Every one has heard the curious story of the "tailed men" of Borneo, who when they wish to sit down have to cut a hole in the ground for the reception of the tail. This story, of course, has always been regarded as a myth, but it is only recently that its origin has been discovered. It has been proved by Mr Bock, in his beautifully illustrated book upon the "Head-hunters of Borneo," that the fable has arisen from the name given to the personal attendants of the Sultan of Passir. They are called "tail-people," which means probably that they follow at the tail of their master (?)

gibbon alone in his progression can dispense with the use of his arms. The chimpanzee, orang, and gorilla when they take to the ground shuffle clumsily along in a semi-erect attitude, using their arms as an aid to their legs. The orang and gorilla have the curious habit of occasionally employing their long arms in the same way as a cripple uses crutches, viz., by placing the knuckles on the ground, and then swinging the body forwards between the arms.

Man alone has attained the perfectly upright posture, and moves freely without the use of his arms; perhaps, however, his tendency to use a walking-stick may be looked upon as a vestige of his former habits!

This important characteristic of man—this erect attitude—is produced by certain graceful and permanent curves in the spine. In the neck the vertebræ bulge forwards; in the back they curve backwards; in the loins they form a convexity forwards; whilst the sacral and tail vertebræ show a convexity backwards. In the man-like apes there is no curve formed by the loin-vertebræ; indeed the only well marked curvature in the spine is that of the sacral and caudal vertebræ. Would it shock those of you who are mothers if I told you that your infants at first present the same characteristics of spine. I mention this not for the purpose of insinuating any relationship between them and the apes, but for the purpose of impressing upon all mothers and nurses the necessity of keeping

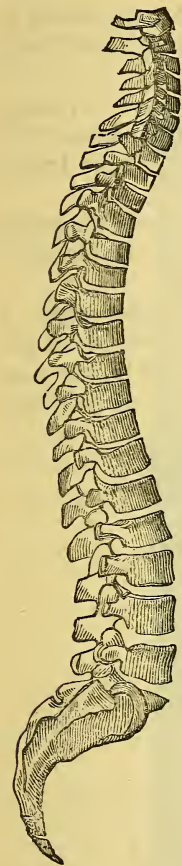


Fig. 1.
Human Spine.

infants at first as much as possible in the horizontal position, until in fact the child gains strength sufficient to enable it to make efforts at raising itself. The spine then begins to assume those curves so characteristic of man, and so essential to a graceful and dignified bearing.

I cannot pass from this subject without pointing out how beautifully the spine is adapted to prevent jars or shocks to the body. The soft cartilaginous discs between the vertebræ act as cushions or buffers, whilst the curves give a springyness to the column similar to that of a spiral spring.

Chest.—This is the cavity which contains the heart and lungs. Behind, it is bounded by the backbone, viz., that portion of it which is formed by the dorsal vertebræ ; in front, by the breast-bone ; and upon either side by the ribs.

The *breast-bone* is a flat elongated bone which tapers somewhat from above downwards, and which the ancients considered to resemble, in some respects, a sword.

The *ribs* are twelve in number on either side in both sexes. I say in *both sexes*, because I know that the idea is not at all uncommon amongst those unversed in anatomy, that in the male skeleton there is a rib wanting, and that woman is the represen-

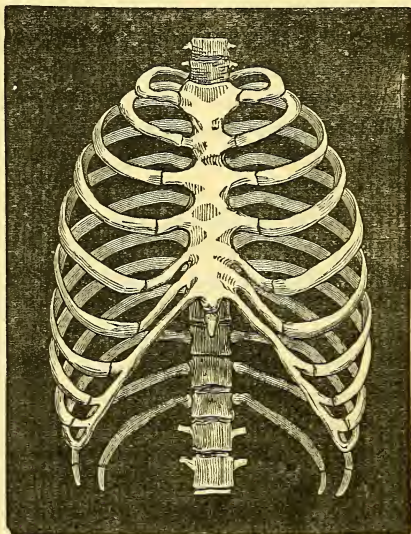


Fig. 2.

Shape of the normal chest.

tative of this missing rib. But this is a popular error. The rib which was abstracted from Adam for the manufacture of Eve has

reappeared in his male descendants. Man, therefore, has been no loser by the transaction, but has recovered his own with usury.

These twelve ribs are attached behind to the sides of the dorsal vertebræ; from the spine they arch forward towards the breast-bone, and as they approach its margin they cease to be

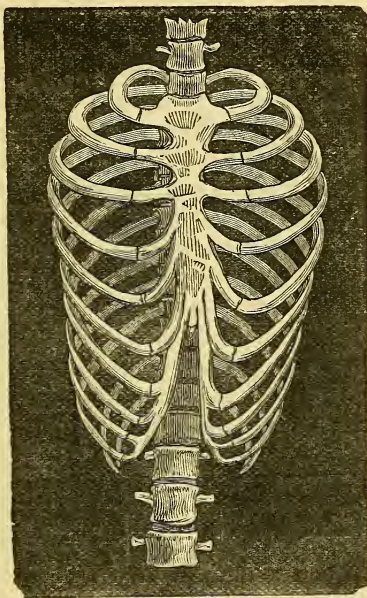


Fig. 3.

Chest of a girl, twenty-three years of age, deformed by tight-lacing. From Rüdinger's work on Human Anatomy. Contrast this with Fig. 2

bony and become cartilaginous. Only the upper seven of these partly bony and partly cartilaginous arches are directly connected to the side of the breast-bone. The succeeding three are fixed in front to the lower border of the seventh, whilst the two last are quite free in front, and are consequently called the *floating ribs*.

This combination of bone and cartilage in the construction of the walls of the chest gives it great elasticity, and contributes very materially to its strength and its capability of sustaining heavy blows without injury.

Let us now examine the shape of the chest-cavity. The chest

is a barrel-shaped cavity distinctly conical in form ; above it is narrow, but it gradually widens out, so that below it attains a very considerable width.

Such is the shape which nature has given the chest, but in modern civilized countries women endeavour to improve upon nature by the use of stays or corsets. This dressmaker's block shows what the conventional idea of a beautiful female figure is, and *nolens volens* nature must be moulded after this pattern. Compare this block with the magnificent outline of the Venus of Milo*—this fine copy of which I am able to show you through the kindness of Sir John Steell. Observe the difference. By all anatomists this statue is considered the very type of female grace and beauty, and for this simple reason, that it represents truthfully the natural female form in its highest perfection.

But so utterly depraved is the popular taste in this respect that I feel I must give more practical and more cogent reasons why stays should be abolished as articles of dress ; and I confess I am ambitious of working some reformation in modern dress-making. These diagrams show the structural deformity of the chest which tight-lacing produces. The chest is no longer conical (*i.e.*, narrow above and wide below), but it has assumed the shape of the stays and is shaped like an egg with the large end uppermost (Fig. 3, p. 29). Lateral curvature of the spine to a greater or less extent is a very frequent accompaniment of this, and the right shoulder is generally rendered higher than the left.

To understand the full enormity of this deforming practice we must examine the effect it has upon internal organs. Stretching across the lower end of the chest-cavity is a thin muscular partition which separates it from the cavity of the abdomen. This partition is called the *midriff* or diaphragm. It is dome-shaped, forming a highly convex floor for the chest and a vaulted roof for the abdomen. Within the chest, as I have already said, are the

* Prof. Flower in his little volume entitled "Fashion in deformity" places with marked effect two woodcuts, side by side, viz., an outline figure of the Venus of Milo and a lady dressed according to the present Parisian fashion. A still greater contrast is obtained by placing a dressmaker's block by the side of the statue,

heart and lungs. These are accurately adapted to the upper surface of this partition. Moulded to the under surface of the

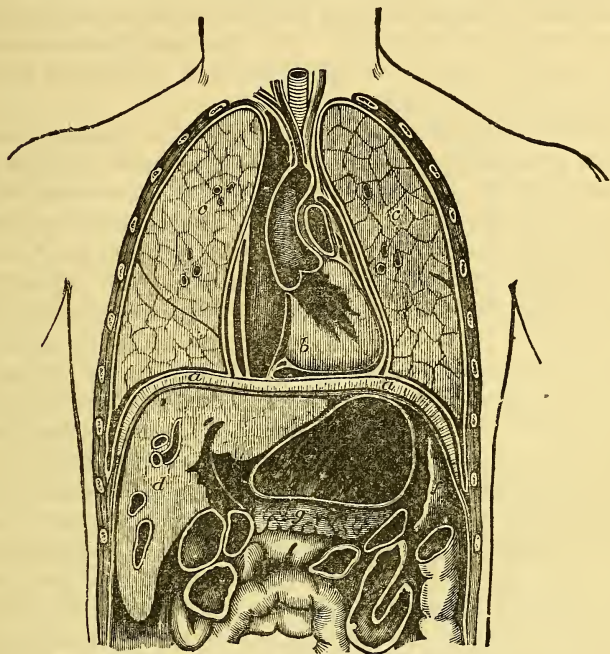


Fig. 4.

Section through the chest and abdomen. (*a*) diaphragm; (*c. c.*) lungs; (*b*) heart; (*d*) liver (*e*) stomach; (*f*) spleen. (Modified from Luschka's Anatomy by Prof. Cleland).

diaphragm is the liver—the bulk of which, however, lies upon the right side of the body. Towards the left side both the spleen and stomach are also in contact with the under surface of the diaphragm. Now the distortion produced by tight stays has mainly two evil effects—(1) it dislodges these organs from their natural position, and (2) it restricts the breathing power. The liver suffers most. Its surface is sometimes deeply indented by the ribs*—sometimes indeed it is driven downwards so as to leave, in

* It is right to state, however, that Prof. Turner looks upon such furrows as congenital, and produced by certain of the ribs lying upon a deeper plane than the others. He has seen the indentations “almost as frequently in men as in women.”

great part, the shelter of the ribs. It has even been found so low in the abdominal cavity as to be resting upon the haunch-bone. The stomach also is compressed and prevented from expanding sufficiently during and after meals. How then can digestion be properly executed when two such important accessories to the process are treated in this cruel fashion ?

But I have said that tight-lacing restricts the breathing power. The act of breathing is produced by the alternate increase and diminution of the capacity of the chest. This is effected by (1) movements of the chest walls, and (2) by the alternate descent and rise of its floor, *i.e.*, the diaphragm. But the walls of the chest when encased in tight stays are bound down so firmly that they can hardly move, and consequently the diaphragm has to do all the work. Now this is the very form of breathing for which women, as compared with men, are worst fitted, and which under certain conditions becomes next to impossible.* The lungs also are so compressed that the blood and air cannot pass freely into them, and the result is that the blood is imperfectly aerated.

We boast greatly of our high civilisation ; we are appalled when we hear that it is the custom of certain barbarous tribes to compress, by means of bandages, the heads of their children so as to give them the shape of a sugar-loaf. I would simply ask you, are we one whit better when we systematically distort our chests ? My belief is that we are worse, because it has not been proved that the compression of the head leaves much evil effect behind,† whilst by distorting the chest we interfere with the most important vital functions of the body.

When I am on the subject of female dress I may as well say that the tendency of the present fashions appears to be to restrain the free movement of almost every part of the body. The Mother Hubbard and Dolman cloaks pin the arms down to the already compressed chest, whilst the skirt of the dress is so tightly tied in behind the knees that only a very limited degree of movement is allowed at the hip-joints. With chest, arms, and

* Pregnancy.

† Up to a comparatively recent period, French mothers, in certain districts, were in the habit of compressing the heads of their infants by bandages. In these cases very evil consequences sometimes resulted.

legs bound up in this manner, like Egyptian mummies in their swathing bands or fowls trussed for the table, the only parts of the body which can move freely are the head and the lower-jaw. How can women expect to be healthy when they neglect one of Nature's great laws, viz., free exercise.

But I fancy I hear you say, "Is this not too sweeping a condemnation? it is only a certain proportion of the sex which lace tightly and wear such apparel." I am quite willing to grant this, but there are very few women indeed who dispense with stays altogether, and however loosely these may be applied they give an artificial support to the spine, and thus detract from its inherent strength. Stays act exactly in the same way as a prop to a tree. It is a well known fact that whenever a tree becomes accustomed to the support of a prop it generally ceases to take strong hold upon the ground with its roots; it in fact relies upon the prop for its support. In like manner the stays weaken the spine. If a corset must be worn, then let it be one with no bones but composed of soft material quilted or corded.

SKULL.—Twenty-two bones enter into the formation of the skull, and these, with the single exception of the lower-jaw, are so firmly united the one to the other that little or no movement can take place between them.

The skull consists of two parts: (1) a portion belonging to the face, and (2) a capacious cavity termed the cranium or brain-case, which is developed for the purpose of protecting the brain.

The bones of the face are *fourteen* in number. They are placed below the forehead, and they are so arranged that they take part in the formation of the walls of the orbits—two deep recesses or sockets in which the eye-balls are lodged—the nasal cavities and the walls of the mouth.

In the lower animals the facial bones are prolonged forwards so as to form a projecting muzzle, which in great part lies in front of the cranium or brain-case. In man the facial bones lie almost entirely under cover of the cranium, and it is only in some of the lower races of mankind, as, for example, the native Australians and Negroes, that we observe a slight tendency to the projection of the jaws. This is a very beautiful provision of Nature. In the lower animals the fore limbs are organs of pro-

gression, and the jaws are prolonged forwards to act as organs of prehension. By them the animal is enabled to obtain its food. The prehensile arms of man render such a provision unnecessary.

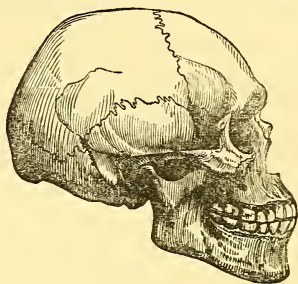


Fig. 5.
Skull of a native Australian (Carpenter)

The *eight bones* of the cranium are united to each other by their margins, and so firmly are they interlocked the one with the other that no individual bone can be removed without breaking up the whole fabric. When we wish to do this it is necessary to apply the force from within by filling the cavity with peas. These when moistened expand and break up the brain-case into its constituent bones. This shows how admirably it is adapted to withstand injury from without.

Taking a skull in our hand and turning its lower surface towards us we observe that its base is perforated every here and there by apertures. These holes are for the purpose of transmitting nerves and bloodvessels to and from the brain. One very large oval opening, called the *foramen magnum*, at once attracts our attention. It is situated just behind the middle point of the base of the skull, and when we place the skull in position upon the top of the spine, we notice that the foramen magnum lies immediately over the spinal canal. This hole, therefore, is the aperture through which the brain is continuous with the spinal marrow.

Upon either side of the fore part of the foramen magnum there is a small elevated smooth convex surface. These fit into corresponding sockets in the first vertebra, and in this way the head is poised upon the summit of the back-bone. In the lower animals

these surfaces are placed much further back, but the erect attitude of man necessitates that they should be placed near the middle point of the base of the skull, so as to balance the head and prevent it pitching forward.

The form of the cranium is subject to considerable variation ; indeed it is recognised by anatomists as being one of the best means of distinguishing the different races of man. We are in the habit of separating skulls into three groups, viz. : (1) *long-headed*, those which are very long as compared with their breadth ; (2) *short-headed*, i.e., those which are very short as compared with their breadth ; and (3) *medium-headed*, those which have a medium length and breadth, or those which occupy an intermediate position between the two extremes.

The negroes and aboriginal Australians are, as a rule, *long-headed* ; the North American Indians are *short-headed* ; whilst the inhabitants of Central Europe are for the most part *middle-headed*. The French are said to possess the most typical medium skulls. The form of the skull, however, cannot of itself be considered a sufficient indication of the intellectual powers of the individual. If this were the case, the French nation would perhaps occupy the highest position. A still more important factor to be taken into account is the capacity of the brain-case. As the cranium is completely filled with the brain, we can, by measuring its capacity, form an accurate estimate of the size of the brain which occupied it. Here again there are considerable differences in the skulls of different races. The European brain-case is considerably the largest, having an average capacity of about 91 c. inches ; the average capacity of the Negro cranium, on the other hand, is only 85 c. inches, whilst that of the aboriginal Australian is as low as 79 c. inches.

But what a prodigious difference we find between the cranial capacity of man and that of the ape ! Of all the points which distinguish man from his nearest of kin in the animal world this is the most striking. Speaking generally we may assert that the lowest cranial capacity which has been noticed in man is twice as great as that of the highest cranial capacity that has been noticed in the gorilla.

The next fact which I have to mention in connection with this

subject is one which I fear will not meet with the approval of the fair sex. But it is a fact which I cannot suppress, viz., that the cranial capacity of the male skull is usually greater than that of the female skull. The average British male cranium has a capacity of 90 to 95 c. inches; the average British female cranium a capacity of 80 to 90 c. inches. The interesting point in connection with this is that there seems to be a greater difference in this respect between the two sexes of the higher races than between the two sexes of the lower races, as say between the negro and negress. If this statement be true (for it still requires to be verified), it would appear that civilisation causes a greater advance in men than in women. Carl Vogt explains this by pointing out that in low races such as the Australians and Bushmen, which possess no fixed habitations, "the wife partakes of all her husband's toils, and has, in addition, the care of the progeny."

The investigations of Paul Broca seem to point to the probability that the advance of civilisation in a people is accompanied by a slow increase in the cranial capacity. He had an opportunity of examining a large number of skulls of the Parisians who lived in the twelfth century. On comparing these with the skulls of the more modern Parisian population, he found that they had a decidedly smaller capacity.*

* A discussion is going on at present in "Nature" regarding "an alleged diminution of men's heads." It seems that there is a prevalent belief amongst hatters that a diminution has taken place. A hatter who has been in business for a great number of years compares the ratio at which hats were purchased 35 years ago with the ratio at which he is at present selling them, with the following result:—

Size in Inches.	Relative Number of Each Bought	
	Thirty-five Years Ago.	At Present.
21	0	3
21½	1	4
22	2	3
22½	4	1
23	3	1
23½	1	0

Professor Flower, who is perhaps the most eminent craniologist in this country, rightly refuses to receive "a fact so contrary to all theory and to all experience" until more exact and more extensive data are produced.

LIMBS.—At the commencement of my lecture I explained to you the principle which leads to the complexity of the animal body, viz., the principle of the division of labour. Now it has been established as a law by Milne Edwards, that the more completely this principle is carried out in an animal the more perfect is its mechanism. In a quadruped, such as the horse, all the four limbs are used for progression, and nothing else, save perhaps defence. The jaws are prolonged forward so as enable the animal to seize and obtain its food. Ascending some steps in the animal kingdom we come to the apes. In these the four limbs are still employed as instruments of locomotion, but each is in addition prehensile. Each, therefore, is endowed with a double function. The jaws are not nearly so prominent, and play but an inferior part to the limbs in the securing of sustenance. In man a still greater difference is found. The lower limbs are framed for locomotion alone, and assume the entire duty of conveying the body from place to place. The arms thus freed from this inferior work are devoted solely to prehension, and become the faithful ministers of the mind. The jaws also have retreated so as to lie altogether under the cranium, and the only function allotted to them is the trituration of the food. The three functions, therefore, of locomotion, prehension, and the trituration of the food which are distributed over the four limbs, and the jaws in the quadruped and the ape, are in man each performed by its own instrument—the labour is thus divided, and man in consequence presents a more perfect organism. But you may ask what advantage is gained by this arrangement? I will answer this Scotch fashion by putting another question. Whether is it better to have in a house three general servants, or three servants—one a trained cook, another a trained housemaid, and the third a trained tablemaid? Am I not right in supposing that the work will be better done by the latter than by the former. The case is quite the same with the human body.

The lower limbs of man then are entirely devoted to locomotion, and in consequence of this they possess a length and a development far beyond that of the most man-like ape. The prehensile upper limbs, on the other hand, are not nearly so power-

ful, and are very much shorter. In the European, when the body is erect the middle finger cannot reach lower down than the middle of the thigh ; in the negro it reaches a little lower. The orang when erect can touch his ankle with his fingers ; the gorilla can touch the middle of his leg, and the chimpanzee his knee.

Let us now, very briefly, look at some points in the construction of the limbs.

In the *lower limb* we recognise a haunch, thigh, leg, and foot. The skeleton is composed of the following bones:—(1) The haunch-bone ; (2) the thigh-bone ; (3) the knee-cap ; (4) the two bones of the leg ; and (5) the bones of the foot.

The *haunch-bones* of opposite sides are firmly jointed together in front. Behind, the sacrum—which you will remember is a bone formed by five of the lower vertebræ, welded together—fits in between them like the key-stone of an arch. The weight of the body is thus transmitted to the lower limbs, and at the same time a cavity is formed which is termed the *pelvis*, so called because it resembles a basin.

The upper portions of the haunch-bones are widely expanded. By this character the haunch-bone of man can be distinguished from that of all other animals. The expansion is rendered necessary by the erect posture of the human body, and it is developed for the purpose of giving support to the intestines. In quadrupeds the weight of the bowels is sustained by the flaccid lower wall of the abdomen, and this is strengthened for the work in large animals, such as the horse, by a powerful elastic tunic, which not only prevents relaxation of the abdominal wall, but also by its elasticity guards the viscera against shocks.

The *thigh-bone* is the longest and most massive bone in the body. Its upper end presents a smooth globular head which fits into a deep cup-like socket upon the side of the haunch-bone, and forms the hip-joint. This rounded smooth head of the thigh-bone is not placed upon its very extremity, but is separated from the shaft of the bone by a constricted neck which joins the shaft at an angle. By this means a much wider range of movement is allowed at the hip-joint.

At this stage I must say a word or two upon *joints*. I will not speak of the immovable joints, such as those between the bones

of the skull where the junction is effected by the interlocking of toothed margins. Nor will time permit of my describing to you the partially movable joints such as those between the two haunch-bones in front and between these bones and the sacrum behind. I will simply direct your attention to a few leading points in connection with the truly movable joints, such as we find between the bones of the limbs.

In such joints the opposed surfaces of the bones are each coated with a thin layer of exceedingly smooth elastic cartilage or gristle. This acts in precisely the same manner as the buffers of a railway

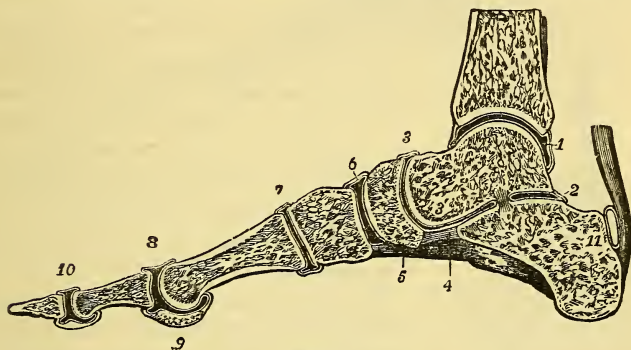


Fig. 6.

Section through right foot, from centre of heel to tip of the great-toe, to show the joints (Quain.)

carriage. When you reflect then that in these joints every bone is separated from its neighbour by two such layers, you will understand the high elasticity and springyness which, by this means alone, is given to the skeleton, and how we are able to carry our bodies about with us with so little inconvenience from external shocks and jars.

Binding the bones together at a joint there are a series of strong membranous bands called ligaments. One of these is usually placed upon each of its four aspects, and they are frequently converted into a continuous and unbroken ligamentous envelope or capsule for the joint by intermediate and thinner membrane which passes between their margins.

A third and very important element in the formation of such a joint is an exceedingly thin membrane called the *synovial*

membrane, which lines the inner surface of the ligaments. It presents a polished glistening surface, from which exudes a viscid fluid—the joint oil. This lubricates the interior of the joint, and allows the cartilage covered ends of the bones to glide smoothly upon each other.

The two bones of the leg lie side by side. They are (1) *shin-bone* on the inside, and (2) the *fibula* upon the outside. The shin-bone is a heavy massive bone, which receives from the thigh-bone the entire weight of the body. The fibula does not reach so far up as to take part in the formation of the knee-joint. The *knee-cap* is a bone with which you are all familiar. It forms

the prominence of the knee, and protects the joint from the front. The fibula is a long slender bone, which is jointed above and below to the upper and lower ends of the shin-bone. Its lower end forms the projection on the outer side of the ankle. The corresponding prominence on the inner side of the ankle is formed by the lower end of the shin-bone.

The mechanism of the foot is so beautiful and so characteristic of man that I must dwell a little more fully upon it.

There are *twenty-six* bones in the human foot. Of these the hinder *seven* are short and stout, and constitute what anatomists call the *tarsus*, *i.e.*, the back part of the instep. In front of the tarsus there are *five* prismatic bones, which are jointed to it, and which lie side by side. These are termed the *metatarsus*, and they form the front part of the instep. The anterior rounded ends of the five bones of the metatarsus rest upon the ground, and are popularly known as the balls of the toes. Each metatarsal bone supports a

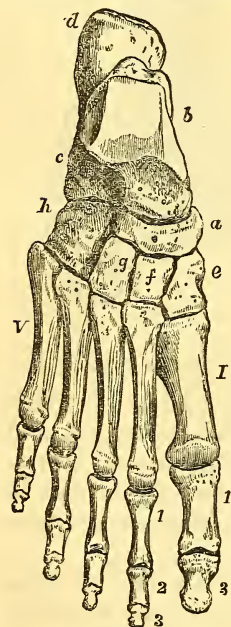


Fig. 7.

a, b, c, d, e, f, g, h bones of tarsus; i to v bones of metatarsus; 1, 2, 3 phalanges of great and second toes (Quain).

toe, and each toe, with the exception of the great toe, is formed by three bones placed end to end. The great toe has only two

such bones. The toe bones are called phalanges, from being placed in rows like soldiers in a phalanx.

The seven bones of the tarsus, together with the five bones of the metatarsus, constitute an arch, termed the *plantar arch*, the height and span of which is greater upon the inner than upon the outer aspect of the foot. The key-stone of this arch is formed by the



Fig. 8.

Section through foot, from centre of heel to tip of great toe, to show the plantar arch.

See also Fig. 6.

highest of the tarsal bones—a bone called the *astragalus* (fig. 7, *b*), This bone supports the entire weight of the body, being clasped between the inner and outer ankles, and it transmits its burden to the summit of the arch. The hinder pillar or pier of the arch is formed by one bone, viz., the heel-bone, which is the largest of the tarsal bones, whilst the anterior or front pillar is formed by several bones. In consequence of this the anterior pillar is highly elastic, and the posterior pillar almost rigid, and therefore, when we jump from a height, we make it an invariable rule to descend upon the balls of the toes, and thus break the shock which we would receive were we to land first upon the rigid heels.

The bones of the plantar arch are held together by dense ligaments. Of these two are specially important for maintaining the arch of the foot. One is a powerful and non-elastic brace, which stretches between the extremities of the pillars, viz., from the under surface of the heel-bone to the balls of the toes (Fig. 8). This ligament, as Professor Humphry has pointed out, acts in precisely the same manner as the tie-beam of a roof. It prevents the pillars of the arch from being pressed too far

apart when the weight of the body, and anything it may be carrying, is transmitted to the foot. The other ligament, I wish to refer to, is highly elastic—just like an indiarubber band. It passes between the heel-bone and one of the tarsal bones which lies in front of it, and the rounded end of the astragalus or key-bone rests upon it (Figs. 6 and 8). When the weight of the body is thrown on the astragalus this ligament gives by virtue of its elasticity, and the key-bone sinks. When the weight is removed the ligament recovers itself, and restores the bone to its former position. The foot therefore gains greatly in elasticity by the presence of this ligament, but it will be easily seen that this gain gives rise to a weak point in the *plantar arch*. In people with weakly constitutions, or when the foot is subjected to great and continuous strains, as in ballet dancers, or bakers who carry heavy loads of bread upon the head, this ligament may become relaxed, and the result is that deformity of the foot which we all know as “flat foot.” This then consists in a destruction of the plantar arch by the descent of the astragalus.

The foot of man is one of the great structural distinctions of the human species. In none of the apes have we a perfect plantar arch, and in none have we so great a development of the great-toe. In man the great-toe possesses a very small range of movement; in the apes it is highly mobile, and resembles in this respect the thumb of our own hand. We must not forget, however, that the capabilities of our foot are greatly interfered with from its being encased in a boot. Every one has noticed the wide range of movement possessed by the toes of an infant. Further, it is a well known fact that in bare-footed people the toes may attain a considerable amount of grasping power. Thus the Australian natives can lift their spears by the foot; the Chinese boatmen can pull an oar; and the natives of Bengal can weave. Not very long ago in Belgium, a gentleman who had been born without arms attained distinction as an artist by wielding the brush with his feet.

We have seen how cruelly fashion deals with the female waist. It is almost as cruel to the foot. An immense amount of pain and misery lies at the door of the shoemaker—corns, bunions, in-growing toe-nails—and all because a boot made according to

the true shape of the foot is considered to be clumsy and inelegant.

Let me point out to you what the true shape of the human foot is. I need not ask you to look at your own feet in illustration of this. Thanks to your shoemakers,* I don't believe that there is a foot in this hall which is quite free from deformity. We must examine feet which are altogether unacquainted with shoe-leather, such as those of an infant or a bare-footed urchin. In such a foot we notice that the toes are widely spread out, and that the great toe stands free from the others. If we draw a line from the centre of the heel along the sole to the extremity of the



Fig. 9.
Natural foot.

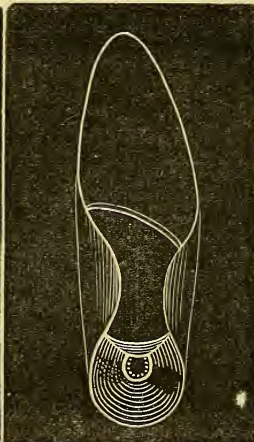


Fig. 10.
Outline of the sole of an
ordinary boot.



Fig. 11.
The common condition in which
feet are found. Great toe
deflected outwards.

middle toe, and another backwards through the middle of the great-toe, the axis of the great-toe is seen to be parallel with that of the foot. How different is the shape of that part of the ordinary boot which encases the toes. The sole is pared away on each side so as to make it pointed in front, or, as Mr Dowie has remarked, as if "a great-toe was in the middle and a

* Of late years shoemakers have been paying more attention to the shape of the foot, but there is still a very great need for reformation in this respect.

little toe on each side like the foot of a goose." In consequence of this the toes are crushed together to such an extent that it



Fig. 12.

A sketch obtained from the deformed foot of a woman only two days before this lecture was delivered.

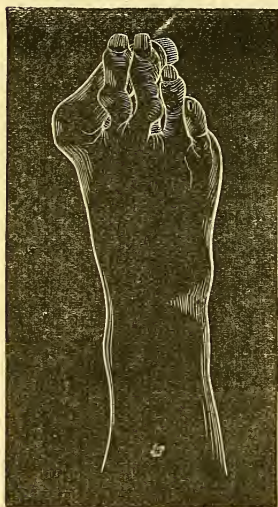


Fig. 13.

Same foot as in Fig. 12,

of the consequences resulting from these.

is not at all uncommon to find one or more thrust upwards or downwards to make room for the others. The great-toe is deflected outwards, so that its direction is no longer straight but oblique. This is harsh treatment for that member which, above all others, we should prize, seeing that it constitutes one of the chief structural distinctions between the human foot and that of the ape. But this is not the worst feature of the case. In walking, running, and jumping the great-toe is the chief agent in the foot for giving to the body the final push as the foot is being lifted from the ground. By looking at these diagrams you will understand how much its action is weakened in this respect when it is forced outwards by a pointed boot.

Had time permitted I would have liked much to have pointed out how the present conventional boot might be improved in its shape. I must simply refer you for information on this to a little pamphlet called "Why the Shoe Pinches," by Professor Meyer.

I must not leave this subject, however, without entering a strong protest against the high narrow heels which usually adorn the fashionable ladies' boot. I have had this diagram prepared in order to show you some

The plantar arch is distorted ; the posterior pillar or heel-bone is so raised that the weight of the body is not distributed equally over the arch but is thrown mainly upon the anterior pillar. In



Fig. 14.
Outline of modern ladies' boot.

order to maintain the equilibrium of the body, the knee has to be kept slightly bent, and the invariable result is a wasting of the muscles of the calf, and a weakening of the whole limb. But this is not all. The heel-piece is seldom placed directly under the heel-bone or posterior pillar of the plantar arch. In great part it presses directly upwards against the tie-beam ligament of the foot into the hollow of the arch. Now in this hollow are placed the blood-vessels of the foot, and they are placed there for the purpose of escaping pressure when the foot rests on the ground. By the high heel this provision of nature is defeated, the circulation is interfered with, and the results are cold feet, and in winter a proneness to chilblains. Why should ladies simulate a practice which they ridicule so much in Chinese women ?

In the *upper limb* we recognise a *shoulder*, an *arm*, a *forearm*, and a *hand*.

Entering into the construction of the shoulder there are two bones—the collar-bone and the shoulder-blade. Together these constitute a part of the skeleton which we are in the habit of

calling the *shoulder-girdle*, seeing that it partially encircles the upper part of the chest on either side.

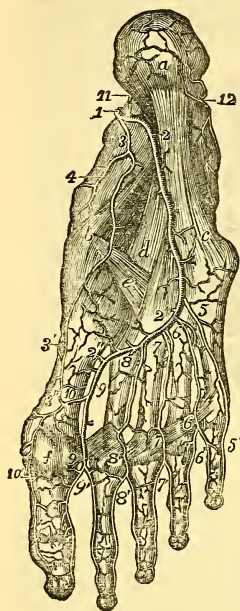


Fig. 15.

Sole of the foot dissected to show the bloodvessels. 1, 2, 3 main arteries of the foot (Teidemann).

been asserted that in the former the collar-bones are slightly longer, and that they are thereby enabled to carry themselves with more grace.

The *shoulder-blade* is a flat triangular bone which lies upon the back of the upper part of the chest. At no point is it directly jointed to the bones of the trunk. Indeed, the only direct articulation between the upper limb and the trunk is where the collar-bone is jointed to the breast-bone.

In the upper-arm there is a single long bone—the *arm-bone* or *humerus*. The rounded upper end of the arm-bone rolls in a hallow concavity or socket which is developed on the upper and outer angle of the shoulder-blade.

The *collar-bone* stretches from the upper end of the breast-bone to the shoulder-blade, to both of which it is firmly jointed.

We have to thank the collar-bone for the wide range of movement which we possess at the shoulder-joint. It acts as a prop to keep the shoulders apart, and in those animals in which it is absent, as, for example, the horse and the ox, the limb can only be moved backwards and forwards. The advantage which is thus gained by the shoulder of man is attended with some risk. The projection of the shoulders renders them very liable to injury. Indeed, fracture of the collar-bone, and bruises and dislocation of the shoulder-joint, are about the commonest injuries that come under the notice of the surgeon.

I don't think that we would readily admit any superiority of carriage in French women as compared with the women of our own country. Still it has

In the forearm we find two bones placed side by side and extending from the elbow to the wrist. Of these the outer is termed the *radius*, and the inner the *ulna*. At the elbow-joint the *ulna* is very extensively connected with the arm-bone or *humerus*; indeed it holds the lower end of the latter in a deep crescentic concavity. The upper end of the *radius* is very small, somewhat disc-shaped, and in contact with the lower end of the *humerus* by its upper surface alone. If we now compare the lower ends of the bones of the forearm, we notice that the lower extremity of the *radius* is broad and expanded, and takes the chief part in supporting the hand, whilst the lower end of the *ulna* is small and button-shaped, and is separated from the bones of the wrist by a triangular piece of cartilage or gristle. Whilst then the *ulna* has a greater share in the construction of the elbow joint, the *radius* predominates at the wrist joint.

Now the *radius*, with the hand which is fixed to its lower end, is capable of performing two very important movements. These movements are termed *pronation* and *supination*. I have said that the *radius* lies to the outer side and parallel with the *ulna*. When the bones have this relative position the arm is *supine*. This is the position which is assumed when we lay the back of the hand upon a table so that the palm looks upwards. Reversing the attitude, however, and placing the palm of the hand upon the table, we produce *pronation* of the limb. The relative position of the two bones of the forearm is now altered. The upper end of the *radius* still lies upon the outer side of the *ulna*, but the large lower end of the *radius* with the attached hand has rolled over the small button-shaped lower end of the *ulna*, so as to lie upon its inner side. The two bones in this condition cross each other like the limbs of the letter X.

In the hand there are three segments, viz., the wrist, the palm, and the fingers.

Entering into the formation of the wrist there are eight small bones, called *carpal* bones, arranged in two rows—four bones in each row. These are so accurately fitted the one to the other and are so firmly bound together by ligaments that it is very rare indeed to find them displaced by an injury.

The soft parts of the palm are supported by five prismatic bones

called *metacarpal* or knuckle bones. These are placed side by side, and are jointed above to the lower row of carpal bones. Each knuckle bone is succeeded by the bones of a finger, which like the corresponding bones of the toes are called phalanges. The inner four fingers have each three phalanges, whilst the thumb has only two.

The hand of man is essentially a grasping instrument, and its high capabilities in this respect are due to the great mobility of the thumb, and the power by which this digit can cross the palm so as to touch the tips of all the other fingers. So important is the hand to the well-being of man that there are some who consider the high mental superiority which man shows over all the lower animals, in great measure due to his being the possessor of so perfect a prehensile organ. Whether this be the case or not, it is at least certain that the mind and the hand are mutually dependent. What use would the mind be to us for inventive purposes had we not the hands to carry out the invention to its practical results.

The ape alone amongst the lower animals can imitate the movements of the human hand, and this very imperfectly. Throw a nut to a monkey and he will pick it up—not between the tips of the fore-finger and thumb—but between the thumb and the side of the bent fore-finger. In many respects the hand of the ape is inferior: thus the thumb is shorter and less mobile; the fingers cannot be so widely separated; and there is little or no power of making the “hollow of the hand.”

MUSCULAR SYSTEM.—I have now given you a very brief and I fear a very inadequate account of the bony-scaffolding of man. We must next consider the means by which this is maintained in the erect attitude; how it is that its various parts are moved the one upon the other; and how it is that the skeleton as a whole moves from place to place. All this is due to the *Muscular System*; not the smallest twitch of an eyelid—not the slightest change in facial expression can be affected except through the agency of *muscles*.

The muscles constitute the red flesh, or what is perhaps better known as the “lean” of the body. There are somewhere about 400 muscles in the human subject. Everyone has seen a leg of

mutton cut across the middle, and has observed the red flesh around the bone. No doubt you have also noticed that this red

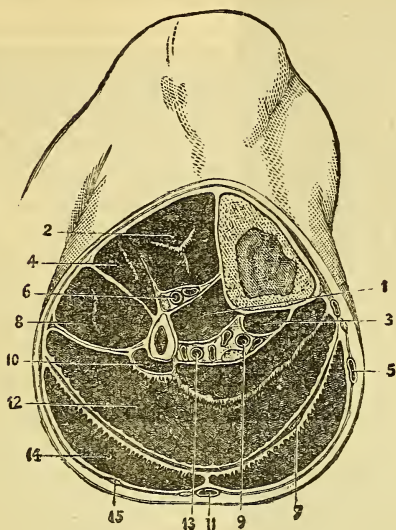


Fig. 16.

ection through leg, 1, 2, 3, 8, 10, 12, 14 various muscles; 9, 13, 11, 6, and 5 bloodvessels, The larger bone is the shin-bone, and the smaller the fibula (Heath).

flesh does not constitute a uniform mass, but is sub-divided into unequal variously shaped areas by white lines, representing fibrous partitions. Now each of these areas represents a separate muscle, and if, in a limb before it has been detached from the body, you were to follow this muscle by dissection upwards and downwards, you would find that the fleshy mass ends at either extremity in a sinew or tendon; and further, that by these sinews it is attached firmly to the skeleton. Understand this, however, that the upper and lower tendons of a muscle are never attached to the same bone, but always to different bones.*

* I refer here to the majority of the muscles. There are some which are attached only by one end to the skeleton, such as those which move the eyeballs and the skin of the face; a few, indeed, can hardly be said to have any attachment to the skeleton, as, for example, a little muscle on the inner side of the palm, which wrinkles the skin and deepens the hollow of the hand.

In the human body, then, we have this enormous number of muscles passing from bone to bone, clothing them and connecting them together. But how, you ask, do they produce the movements of the body? They perform this by their power of contracting; every muscle is capable of shortening itself, and thus approximating its terminal tendons and the bones to which these are fixed. The tendons have no contractile power. They act therefore just like the traces which connect the horse to the cart—they play a passive part.

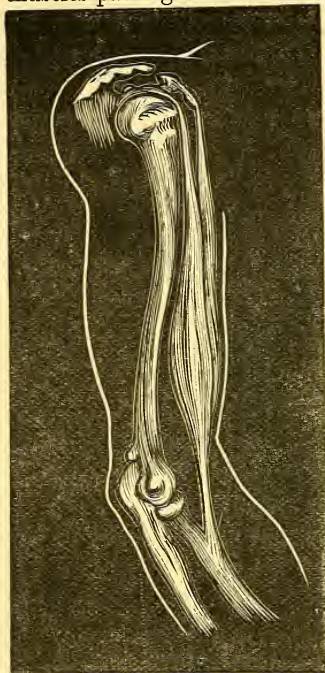


Fig. 17

Forearm extended, Biceps muscle relaxed and at rest.

Let me illustrate this to you by taking one muscle as an example. I will choose for this purpose one with which you are all familiar, viz., the *biceps*. This muscle, as you know, forms the projecting mass in front of the joint of the upper arm, where the limb is bent forcibly at the elbow joint. Above it is attached by two separate tendons or heads (hence its name *biceps*) to the shoulder-blade; below it is fixed by a cord-like sinew to the

radius or outer of the two bones of the forearm a short distance below the elbow. When it contracts, it bends the forearm at the elbow, like a door upon a hinge; and as the contraction of a muscle is always accompanied by a corresponding thickening, or increase in breadth, we have a marked prominence produced in front of the arm.

For the performance of voluntary motion, something more is required than the mere muscles. Each muscle must be brought under the influence of the nervous system; therefore entering it we always find one or more nerves. These nerves connect the various muscles with the brain and spinal marrow, and by them

the movements of the body are excited and controlled. The influence of the nervous system in this respect is manifested by the effects produced by intoxication, or by the disastrous results fol-

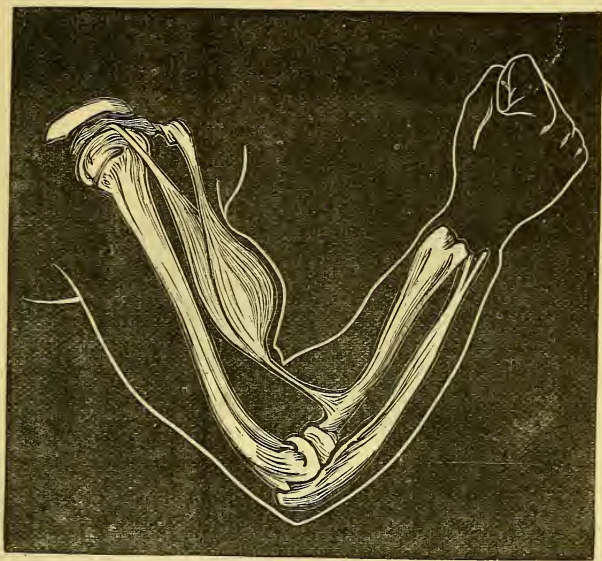


Fig. 18.

Forearm flexed at the elbow joint. Biceps in contracted condition.

lowing apoplexy. The tottering gait and the double vision of the drunkard are caused by the alcohol acting upon the nervous system in such a manner that it is rendered incapable of producing harmonious contractions of the muscles. The sudden collapse of the frame, when apoplexy occurs, is due to a destruction of brain-matter from the rupture of a small bloodvessel, and the pouring out of the blood into its substance.

In addition to the nerves, each muscle is entered by blood-vessels—arteries to carry blood to the muscle, and veins to drain it away. The blood supplies the muscle with the energy requisite for its proper contraction.

Before I finish, let me urge upon you the necessity of exercising

the various muscles of the body. Allow a muscle or a limb to lie unemployed, and it shrinks and wastes. A good physique and a graceful bearing can only be acquired by giving each part of the body its proper amount of regular exercise. But exercise is of

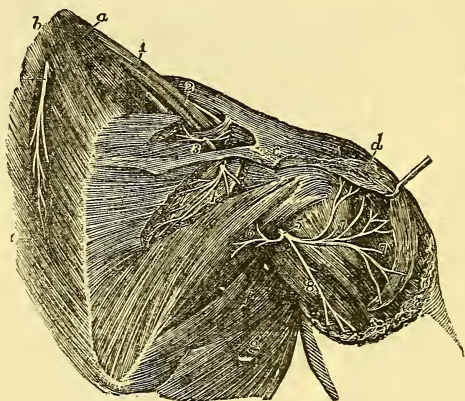


Fig. 19.

Nerves entering muscles of shoulder (Hirschfeld and Leviellé).

value not only for the muscular and skeletal systems—it is an essential for the right performance of every function in the body.

I am now finished. I have confined myself almost entirely to bones and muscles. Dr Tuke will introduce the brain into the cranial cavity. Dr Jamieson will clothe the body with its protective covering, the skin, and Dr Foulis will fill the cavity of the abdomen with the organs of digestion. Last session the contents of the chest cavity were fully described to you.

PARASITES,

IN THEIR RELATION TO FOOD AND HEALTH.

WITH ILLUSTRATIONS.

BY DR ANDREW WILSON, F.R.S.E., F.L.S., &c.,

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Faculty of Medicine, University of Glasgow, &c.*

MR CHAIRMAN, LADIES, AND GENTLEMEN,—There can exist no doubt that the idea which is evoked by the term parasite is anything but an agreeable one. For, if we even look at the name as it has been metaphorically applied to certain individuals of the human species, we shall find that the term indicates a cringing, despicable unit of humanity, who, as in the days of ancient Rome, was ready to follow at his patron's heels, and to execute any commission however base or ignoble, which that patron might command. And when we turn to the purely scientific aspect of the term "parasite," the associations connected with the name are again anything but agreeable. But life is not all "sweetness and light;" it has its unsavoury but apparently necessary side as well; and a very important necessity exists for our knowing something, not merely about the nature of parasites, and about the ranks of the animal and vegetable worlds from which they are derived, but also concerning their special effects upon the human organism and upon the bodies of lower animals as well.

The importance of this subject, in so far as the general public are concerned, will be best demonstrated by a reference to "parasites" as they affect our food-supply and our health itself. But I should first desire, in commencing my lecture to-night, to ask your attention to a correction of one or two ideas concerning "parasitism" at large. We are too apt, from that popular standpoint, which utterly neglects the conclusions of natural history

science, to regard a parasite as being a thoroughly unnatural animal. Now, the naturalist, in reference to the history of any animal form, considers, amongst other details, its "distribution," and in so doing has his attention directed to the different quarters or "areas" of the world which animals and plants are found to occupy. When, therefore, we study the bodies of animals and plants in this light, we discover that a very large and important area of habitation is opened up for animals and plants of a lower kind. We learn that it is not in the least unnatural, if we may judge by the frequency of the habit, for one animal or plant to live in or upon another living being—animal, or plant, as the case may be. In fact, the more we know about this subject, in a purely biological or zoological sense, the wider we discover the sphere of the parasite to be—so wide, indeed, that in one sense it may almost be said to be co-existent with life itself. The words of the witty Dean Swift apply most aptly to the wide distribution of parasitic life:—

So, naturalists observe, a flea
Has smaller fleas that on him prey,
And these have smaller still to bite 'em,
And so proceed *ad infinitum*.

These words undoubtedly contain a large amount of scientific truth. For, in many cases, we may find even the parasite itself to be assaulted by humbler life. But, in any case, the wide distribution of the parasite, and the thoroughly natural character of the parasitic home and habitation, is a zoological idea which may well be impressed upon you at the commencement of this lecture.

In taking a brief and general survey of parasitic life, we may begin with the lowest fields of plant existence, and pass upwards to the highest animal life—that of man himself, who is not merely not exempted from parasitism, but who presents special attractions for the ravages of certain kinds of these organisms. To commence with the very lowest rank of life, we find many of the so-called "germs" which are almost undiscoverable by the highest powers of our best microscopes, presenting themselves under a parasitic guise and habit. Many of you will remember that at the recent meeting of the Social Science Congress in Dublin, Dr Cameron

read a paper detailing the results of Pasteur's observations in connection with the organism which has been found to cause *splenic fever*, a peculiar disease, otherwise known as *charbon* and carbuncle, or, in popular English, "a plague of boils," which affects sheep, cattle, and other animals, and may be transmitted from them to man. The researches of M. Pasteur have proved that this disease is caused by an organism, probably a plant, of the humblest grade; the full history of which takes almost the scientific work of a lifetime, and a patience excelling Job's, to discover. Then, passing from these "germs," which undoubtedly are the causes of our zymotic diseases and fevers, to parasitic plants, we find illustrations of parasitic habits in certain plants, several of which will be perfectly familiar to all. For instance, take a plant which will acquire historical and social importance a few weeks hence—the mistletoe. This plant is a parasite of the oak and the apple tree. Yet, it is not a perfect parasite, because, having green leaves of its own, it can, to a certain extent, make food for itself. The parasitic plant known as "dodder," which ruins our crops when growing in abundance through a process of literal strangulation, is a purer parasite than mistletoe, in that it is dependent for food on the plants to which it pays its nefarious attentions. But if you study the history of lower plant life more intimately, you will learn that nearly three-fourths, if not a larger proportion, of the skin-diseases of man are caused by lower vegetable growths. Thus, for example, you have the *tinea* or "ring-worm," caused by a low fungus called *Tricophyton* by botanists. Then, again, you have *favus* affecting the scalp, and that again is a skin-disease caused by a fungus of another kind called *achorion*. There is also another well-known skin-disease—which is in fact a genus of skin diseases, having a considerable number of species or varieties—called *herpes*, which not only affects man, but which may be transmitted from him to animals. This also is the direct result of the growth of a particular kind of fungus in the skin. We thus discover that the lower orders of plants possess, even in the domain of human life, a very wide area of distribution. And passing to a lower life-form still, we shall discover the silk-worm to be affected likewise by a parasitic

form of plant life. In other words, we shall have to recognise as a pest of the silk-insect, the small *Botyrtis*, a microscopic plant, which nearly ruined the commercial prosperity of France a few years ago, in so far as the silk-producing industry was concerned by causing the *muscardine* disease.

I need not say more on this head to show you how life in its lower deeps possesses relations of importance and interest with life in higher ranks, or even its highest grades. We may now try to trace, in order to obtain an intelligent view of our subject, how parasitism begins. We shall find that this condition, like most other conditions of animal life, exhibits grades and stages advancing from small beginnings towards a more perfect and representative type. We may, perhaps, make clear the relations between parasites and the animals they affect through the use of an extremely common-place metaphor. How, for instance, should we define, in social life, the relations existing between the "lodger" and his "host" or landlord? Probably by saying that the former received shelter from his host, but was not dependent on him for anything else in the way of food. More plainly, the pure "lodger" has to do his own cooking and providing; and so the first class parasites we shall call "animal lodgers."

In a diagram before you, there is represented the animal known as the sea-anemone. The poet Southey long ago called them "animal-flowers;" and as you see them in the rock pools of the Firth of Forth, or indeed in any other locality, you can realise the beauty and applicability of the poet's simile. It is a creature entirely flower-like in its appearance; with a central mouth, surrounded by a perfect array of tentacles, adapted for capturing the prey in the shape of the unwary crabs that stumble against them. Now, it is a well-known fact that some of the large species of tropical sea-anemones act the part of "hosts" to certain small fishes. The fishes have been seen to swim in and out of the mouth of the anemones, and are known to dwell in their body-cavity. This relationship becomes the more surprising, when you reflect that a single touch of your finger, far less placing your finger within the mouth, causes the

anemone at once to contract itself in the fashion represented in the diagram and to become, from a flower-like form, a mere conical mass of jelly. Place that fact in relation to the previous one, and I think you can readily understand the beginnings of the parasitic life here. For, however the association began, the fish may be said to be a mere "lodger" within the body of the anemone. It feeds outside the host's body, or, in other words, "dines out;" but the curious fact of its lodging safely within the body of an otherwise voracious animal, remains to illustrate a new phase of placing one's head "in the lion's mouth."

Passing from the relation of the mere animal "lodger," we find a something added to the functions of the latter, when we discover that some animals literally "board" as well as "lodge" with another animal. The "boarder" in human life, is not merely taken in by the host, but he is taken in, and, in polite parlance, "done for." Here, however, we may realise some examples of what is said to be the practice of some sharp "boarders" in human life—that of "taking in" and "doing" their landlords. If we reflect, at least, upon the harm the parasitic boarder, living in the very kitchen, or digestive system of its "host," may do to the latter, we readily see the analogy between the dishonesty of the human, and the harm of

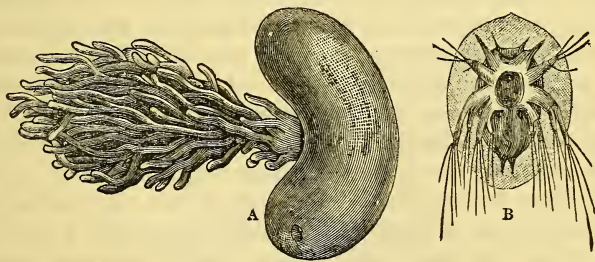


Fig. 1.

SACCOLINA—A, Adult, showing the roots of attachment. B, Young *Sacculina* or *Nauplius*.

the animal parasite. Here, on the wall before you, is a very well-known parasite called the *Sacculina* (fig. 1. A), which attaches itself to the bodies of hermit crabs. The *Sacculina* may be said to be

merely a sausage-shaped sac or bag. Suppose, then, we have such a sac-like animal, without any definite internal organs, but from whose body a number of roots grow into the crab's liver, we may thus discover a parasite, not merely depending upon its host for lodgment, but one which also feloniously abstracts from that "host" the nourishment it provides for its own wants. The history of a *Sacculina* is, however, worth a moment's study. This curious organism begins life as a little free swimming animal (fig. 1. B), possessing three pairs of legs, and called a *Nauplius*. It has an eye in the middle of the body ; but it possesses no internal organs, however, and it bears a resemblance to those animals called "water-fleas," which as many of the citizens of Edinburgh will remember attracted a considerable deal of zoological attention, on the promulgation of a certain defunct water scheme. Indeed, the *Sacculina* stands somewhat in the position of a "poor relation" to the "water-fleas" themselves. But a noteworthy fact in the history of the *Sacculina*, is that this sac-like parasite, itself a lodger and boarder on the crab, starts life under the guise of a water-flea, and only drops its legs and other organs when it settles down ultimately into the parasitic condition. For, after a free swimming life, the little *Sacculina* loses its legs and its eye, and, attaching itself to the crab, develops its roots, and becomes the mere pulsating sac (A) I have described. It thus furnishes us with an example of an organism becoming degraded, or backsliding, as it were, from a higher to a lower condition. And its history teaches us, amongst other things, that the original condition of most if not all parasites is a free-living state. Their parasitic habits, like habits amongst ourselves, are things which grow by degrees, and in time become the normal way of life. But in the case of a third series of parasites, the history of which I am about to describe, we shall find animals which are not merely "lodgers" or even "boarders," but in addition may be called "tenants by right." If we study the tape-worm or the fluke—the former inhabiting the alimentary canal of man or of the other warm-blooded animals, and the latter living in the bile ducts of the sheep's liver—we may discover that these parasites are not

merely in a position to obtain lodgment and food at the expense of their hosts, but may be said to be in their whole history "tenants by right." They pass through the whole course of their development within the bodies of their hosts; and they select, through the operation of the laws of their life, a particular position, which they come to acquire as their lawful and natural area.

We thus find that parasites may be conveniently classified into (1) pure "lodgers," a condition representing the beginnings of parasitism; (2) "boarders," or that more advanced state wherein one animal becomes dependent on another for food as well as for lodgment; and (3) "tenants by right," under which class we find the most typical parasites, dwelling usually in one particular part of the animal which they affect, and in that part or organ alone. Parasitism, as I have already remarked, has its degrees and stages of perfection; and this observation, therefore, clearly shows that it is an acquired, and not original, condition.

The human area and its parasitic tenants may now engage our attention. It is in this department of inquiry that the main current of our thoughts to-night may be said to flow; and it is in this aspect of our subject that its relations to health are most clearly to be traced.

The human area, it may be remarked, presents a very considerable number of parasites for the notice of the naturalist. Some of these are harmless, others are annoying, and others, again, are of a highly dangerous character. As an illustration of the harmless type of parasite, we may select one which, as it happens, has no common name, but only a scientific appellation. It is called



Fig. 2.

Demodex, a mite inhabiting the follicles of the human skin.

Demodex (fig. 2), and its specific name is *folliculorum*—a name indicating that it inhabits the little crypts or follicles of the human

skin. There is one position in man which it invariably occupies, and that is the follicles of the skin at the sides of the nose. Its average length is about the eightieth part of an inch. It is unquestionably a kind of mite, but it exhibits that degradation of structure which we have noted to be the results of parasitic existence. It resembles the ordinary mites in having four pairs of legs, and in other characteristics of the class ; but we discover that the legs have degenerated to form mere stumps, so that the animal, in obedience to the law of use and disuse, and having no need of limbs, has become limbless accordingly. It is believed on the best authority that very few individuals are exempt from this parasite. Some statistics say forty out of sixty persons possess *Demodex* as a tenant ; others maintain the proportion to be one in ten. We are ignorant of its existence, very probably, from the fact, that it is so thoroughly harmless. But in the dog it may give rise to annoyance, as it has been estimated that in a single follicle of the dog's skin no fewer than 200 of these parasites may be found. The dog, therefore, exhibits in an increased degree a condition which is harmless in man. The species which affects the dog is slightly different from that which exists in man. In *Demodex*, then, we see illustrated a case of pure parasitism, but one, at the same time, of a harmless kind. Very different, in the results of its life at least, is the parasite which produces the disease known as "itch." This parasite is likewise a mite, the female of which burrows beneath the skin, and forms regular channels or galleries in that tissue. This mite also exemplifies the operation of the law in parasitism that degeneracy follows disuse, for the two hinder pairs of legs are only partly developed. It is a well-known fact that in the case of this mite unhealthy conditions of body, or want of attention to personal cleanliness, are predisposing conditions for its attacks ; preparing the skin, as a soil is prepared for the seed, to become the habitat of this animal.

The parasites which next await us, bring us directly within the domain of the physician and sanitarian. All parasites are not of equal importance in relation to human health. In one case a parasite, such as the *Trichina*, may affect man so powerfully that its invasion may be attended with a fatal issue. There are other

parasites, such as the tape-worms, which do not produce death, but which may produce very serious constitutional disturbance, and lay, at any rate, the beginnings of ill health. Then there are parasites which affect man in relation to climate, and which produce disease only under special conditions—such as that of tropical climate, for example. Such is the Guinea Worm, now and then seen in British hospitals, burrowing beneath the skin of the legs, and giving rise to painful swellings. But these latter considerations lie outside the main drift of my remarks to-night. For unquestionably it is those parasites that have the power of affecting us through our food, and through their being included in our dietary, which possess for us the highest importance.

In such a parasite as a "tape-worm," we may find a convenient starting point, because these parasites are unquestionably the most common visitants of the human territory. Let us firstly inquire, What is a tape-worm? In the answer to this question you will find a natural history study of, I hope, some little interest. The tape-worm has received its common name from its very obvious band or ribbon-like shape. In looking at it closely, we discover that all its parts are not of equal value or importance. Thus a tape-worm which may measure 20 feet in length, perhaps, possesses firstly a *head* (fig. 3, 1), which may not be larger than the head of a small pin. Immediately succeeding the head is a number of small joints forming the so-called *neck* (Fig. 3, 1 *d*) of the animal. Then succeeds the great bulk of the animal, composed of a series of *joints*. There are thus three elements in a full-grown tape-worm—*head*, *neck*, and *joints*. But when we think of a tape-worm, we almost insensibly glide into the idea that it must correspond to an ordinary worm, such as an earth-worm or a sea-worm. The naturalist, however, will speedily show cause for a change of ideas on this point. He will tell us that in considering the tape-worm we are regarding not one animal, but a veritable colony of animals—not a *single* individual, but a *compound* individual. Study for a moment how the tape-worm grows. The animal is ever increasing in length, and new joints are continually being produced from the neck extremity. The oldest joints are those which are furthest away from the head.

So long as the tape-worm head remains attached to the lining membrane of the alimentary canal of the animal it inhabits, so long it goes on producing joint after joint, and so long it adds largely to its increase and individual extent.

But let us now examine the constitution of a tape-worm "joint" (fig. 3, 2). The thin joint of a tape-worm is remarkable in one respect, namely, in that its whole interior seems to be occupied by an *ovary*, or egg-producing apparatus. We also note that each joint possesses an individuality of its own. The branched or tree-like structure you see in the centre of the joint (fig. 3, 2) is the ovary; and when you learn that each joint contains many thousands of eggs—or when you consider, in the light of that fact, that a tape-worm possesses hundreds of such joints—you can form some adequate conception of the enormous number of eggs which

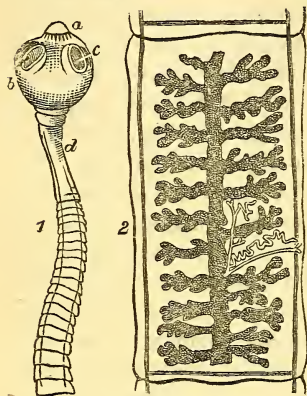


Fig. 3.

ANATOMY OF A TAPEWORM.—1. The head and neck (largely magnified)—*a*, hooks; *b*, head; *c*, suckers; *d*, neck. 2. A single joint (*proglottis*), (magnified), showing the branched ovary and the generative pore or opening at the right-hand margin of the joint.

a single tape-worm is capable of producing. The tape-worm head is provided with a circlet of small hooks (*a*), which enable it to attach itself to the lining member of the intestine, whilst four suckers (*c*) also aid this attachment. Thus, we see in each joint of the tape-worm a semi-independent animal, and a distinct member of the elongated colony. Each joint is capable of producing perfect or fertilised eggs, and each egg can give origin to a new tape-worm, when the egg is placed under the requisite conditions for ensuring its development.

The development of the tape-worm becomes a subject of the highest importance, from a sanitary point of view. The eggs contained in the joints, escape from the body of man, and are distributed usually in sewage over the surface of the earth. It must be borne in mind that the egg of the tape-worm is a structure

which, even before it leaves its "joint," or parent-structure, already contains within itself the young animal. The egg appears at this time as a small sac or bag, with a tolerably hard outside envelope, within which is the minute embryo, or young animal. The very earliest or primary steps of development have been undergone even while the egg was within the joint, and when the latter was within the body of its "host." Now, this egg requires to pass through a complex cycle of development; and we may at least gain one comfort in our study of the life-history of this parasite, namely, that the chances of destruction which await the young worm in the course of its development are so great, that in reality the tape-worm race is thus prevented from becoming a literally teeming population on the face of the earth.

We naturally divide the life of a tape-worm into two "epochs." The first epoch is passed within a different animal from that which harbours it in the mature state. The first host in the case of the common tape-worm (*tænia solium*) is the pig, and the second is the man. Suppose that the egg of a tape-worm is swallowed by a pig, the stages of its development are easy to trace. Development would then proceed, and would end by placing the worm before us at the end of its youth. If a man swallowed the egg of the common tape-worm, it would, as in the pig, simply end by becoming an imperfect worm. For the egg, to develop into a human tape-worm, requires to pass the first part of its history within a different "host" from that in which it attains its maturity; and the first "host" in this case, I repeat, is generally the pig. If, therefore, a pig swallows the tape-worm egg obtained from the digestive system of man, the gastric juice of the pig's stomach soon dissolves away the covering of the egg, and the small embryo is liberated. Under what guise does this young worm appear? As a "boring larva," or, as naturalists call it, the *proscolex*. Its name of "boring larva" indicates that it possesses a boring apparatus of hooks, and by aid of these hooks—not being permitted by the laws of its development to stay in the digestive system of the pig—it bores its way from the pig's stomach to take up its abode in the *flesh* or *muscles* of the animal. But

even here, it cannot become a perfect animal or tape-worm. Within the pig's body, in short, it cannot advance beyond its youthful stage. Located in the muscles of the pig, it develops around its body a kind of bag or "cyst;" and, appearing in this guise, was known of old as a "cystic worm" or *scolex*, before its true nature was suspected. These young worms may be discovered as mere white specks in the flesh of the affected animal.

Here, then, the days of the tape-worm's youth may be said to end. If, as is extremely unlikely, the pig dies a natural death, and is respectably interred, there is an end at once to the pig's troubles and its aspiring tape-worm guests. But if, as is more likely, the pig passes into the hands of the butcher, the beginning of the tape-worm's adult stages looms in the distance. If a veterinary surgeon were to see the flesh of the infected pig at this stage, he would at once pronounce it to be unfit for human food, and he would in addition inform us that the pig had been attacked by "measles." "Measles," in this sense, is simply a name given to the symptoms produced in the pig and other animals by the boring inroads of the youthful tape-worms.

Now, if a piece of that pig's flesh should be eaten by a man the second part of the life-history of the tape-worm is immediately inaugurated. For, when the little cystic worm from the pig's flesh lodges in the human stomach or intestine, the bag or cyst falls away, and the little head and neck are alone left. But the head and neck contain, *in posse*, all the vitality necessary to produce the mature tape-worm. The head attaches itself to the lining membrane of the man's digestive system by its hooks and suckers. Thus located, the neck begins to produce its joints in the form of buds. The buds nearest the head, at first immature, soon acquire all the characters of well-developed "joints," as they are pushed further and further from the head. These joints develop the egg-producing apparatus, and other organs proper to adult tape-worm life. And thus, in due time, you find the budding tape-worm arriving at the stage from which we started—namely, at the adult or parent form, ready to send abroad its eggs, each of which is again capable of illustrating this marvellous cycle of development.

Thus, the life history of a tape-worm may be succinctly summed up by thus tabulating its stages :—

1ST EPOCH.	{	(1) The <i>Egg</i> , liberated from the human digestive system.	} The Pig is the "Host."
		(2) The <i>Boring Larva</i> or <i>Proscoplex</i> passing from the pig's stomach to its muscles to become—	
		(3) The <i>Scolex</i> , or <i>Cystic</i> , or <i>Bladder worm</i> .	
2D EPOCH.	{	(4) The <i>Immature Tape-worm</i> , consisting of the head and neck of the <i>Scolex</i> eaten by man in the muscles of the pig, giving origin to—	} The Man is the "Host."
		(5) The <i>Perfect Tape-worm</i> in man's intestine, produced from stage 4 by budding.	
		(6) The <i>Joints</i> , which are continually passing from man's intestine, and which contain, each thousands of eggs, leading us back to stage 1.	

Other tape-worms having an essentially similar history may be found within the human domain. The form we have just considered is the *tænia solium*, the first "host" of which, as we have seen, is the pig. But it so happens that we obtain from under-done beef the *tænia mediocanellata*, or the "beef tape-worm," as it is called. Naturalists call its immature stage the "beef-measle." This worm may attain a length of 30 feet, but, unlike the *tænia solium*, its head is utterly unarmed. If we study the life-history of this second tape-worm, which is obtained from under-done beef, it will be found to exhibit the same stages as the *tænia solium*; the only difference being that we should have to insert the ox as the first, and man as the second "host." But far more important is it to understand that this principle is carried out practically in all tape-worms—that is to say, that we never find any given tape-worm perfect in the same animal from which we obtain its early or "scolex" stage. Thus, the little cystic worm which exists in the liver of the rabbit, becomes, when eaten by the dog, a tape-worm of that animal. The little cystic worm or "scolex" of the rat and the mouse, becomes the tape-worm of the cat; and another curious cystic worm that inhabits the brain of the sheep becomes a special tape-worm (*tænia cænuræ*) of the dog.

But that a much more serious form of parasitic attack, in so far as the tape-worm race is concerned, awaits man, is disclosed by the history of another tape-worm (*Tænia echinococcus*) (fig. 4), which inhabits the intestinal canal of the dog. This is one of the smallest of the tape-worms, and seldom exceeds $\frac{1}{4}$ of an inch in length. It develops only some four joints, including the head (a), which has a double crown of very large hooks for attachment to the dog's digestive tract. Four suckers also exist for the same purpose. This small parasite, however, acquires a high importance in the human area, from the fact that man may become the first "host" in its development; just as the pig is the first "host" to his own tape-worm. Thus, if man swallows the egg of this tape-worm—obtained, say, from the surface of unwashed vegetables that have probably borne some relation to sewage manure—the egg passes, not to the muscle or flesh of man, whither we traced the egg of the *tænia solium* in the pig, but, as a rule, to man's liver. It rests in the liver, just as the "measle" of the pig rests in the flesh of that animal; and in the human liver this youthful tape-worm of the dog gives rise to an aggravated form of liver disease known under the name of *hydatids*. The liver in a bad case of hydatids exhibits a series of fluctuating tumours; and after death—for only too frequently the disease has a fatal ending—we may find the liver to be perfectly invaded by these cysts. The destructive nature of these young tape-worms in the liver is chiefly due to a peculiar characteristic of their development. The young forms of the common tape-worm in the muscles of the pig or ox are each of single nature. But each young *scolex* of this dog's tape-worm, when settled in man's liver, has the power of producing other cysts, or "heads and necks," in its interior by a process of budding. The parent, or first cyst or bag, may thus attain a very large size, and then appears as a large tumour in the liver, filled



Fig 4.

Tænia echinococcus from the Dog. a, head; b, the last and mature joint; c, the generative pore (magnified after Cebbold).

with fluid, and containing within it "daughter cysts," as they are called, each of which, in turn, may contain many "heads and necks." Each of the latter, if swallowed by a dog, would of course give rise in that animal to the mature tape-worm.

A curious fact concerning tape-worms is found in connection with the history of the broad-headed tape-worm, or the *bothriocephalus latus*. This worm is never found native in England or Scotland; but it has been called the "Irish tape-worm," because it is indigenous in that country, where it may thus constitute a real "Irish grievance." It is certainly common in Western Switzerland and adjacent parts of France, and it also occurs in Geneva, and in Northern Russia and Sweden. This tape-worm is supposed by some authorities to pass its first stages of development within the bodies of certain fresh-water fishes of the salmon and trout kind; or, according to others, within the fresh-water fish known as the bleak. Some naturalists, on the other hand, maintain that this tape-worm may need no first "host" at all. We know that from its eggs, when placed in water, a little free boring embryo issues. But, as my friend Dr Cobbold remarks, the very presence of these hooks suggests that this young worm must naturally bore its way into the tissues of an animal, just as the youthful scolex burrows into the flesh of the pig. Be that as it may, the important fact to be borne in mind is this—that a fish-eating population is liable to incur infestation from these tape-worms, just as the flesh-eating population is liable to infestation from those to which I have already referred. A point of interest in the history of this "broad-headed" tape-worm is its size. It may have as many as 4000 joints, and may grow to be 25 feet long, and over an inch in breadth.

Before quitting the group of the "flat worms," let me remark in reference to the "hydatids" of the liver of which I have spoken, that this is a disease extremely prevalent in Iceland, owing to the immense number of dogs kept by the peasantry, and owing to the familiarity with which the canine population is there treated. An Icelandic peasant may often possess half a dozen dogs, which share his habitation, and it is obvious that the unnecessarily close relationship of the dog and his owner in such

a case, gives opportunity for the passage of the germs of this parasite from the dog to the man. The high importance of sanitary precautions in the matter of dogs may be seen, when we learn that "almost the sixth part of all the inhabitants annually dying in Iceland" fall victims to the hydatid disease.

Last of all may be mentioned, in connection with the tape-worm group, the curious history of the *tænia cucumerina*, another species infesting the dog's intestine in its mature state. The eggs of this worm, passing from the intestine of the dog, are swallowed by the dog-louse infesting the animal's skin. In the louse, as a first "host," the worm attains its *scolex* stage, just as the young tape-worm of man attains that stage in the pig. The dog next swallows the louse in cleaning his skin; and thus introduced within the digestive system of the dog, the young tape-worm from the body of the louse, develops into its mature form within its canine host, whose body it has literally never left throughout its development. The "vicious cycle" of parasitism is plainly detailed in such a case as this, whilst Dean Swift's lines find here a highly practical illustration.

Passing now to the Liver Fluke (*Fasciola hepatica*), which, although not of much sanitary interest, may yet affect man, we discover in the fluke a parasite which kills thousands of sheep every year, by inducing the disease known as "rot." The fluke you may see for yourselves by procuring the liver of the sheep, and examining the bile ducts. It is a flat, oval body (fig. 5), about half an inch in length, pro-

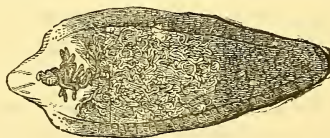


Fig. 5.

THE LIVER FLUKE (*Fasciola hepatica*.)

[The "head" extremity exists at the left-hand side of the figure.]

vided with suckers for adhesion, and resembling in many respects the single joint of a tape-worm. Each fluke is capable of producing large numbers of fertilized or perfect eggs; but it is a

single animal, and not like the tape-worm, a "colony" of forms. Occasionally the fluke may be found within the human domain. Surgeons and physicians have now and then put on record curious cases, in which this fluke has occasionally been found burrowing beneath the human skin and scalp. But these are rather rare occurrences. The only explanation which may be given of such cases is that which shows that in all probability man obtains the fluke exactly as the sheep obtains it, namely, from drinking impure water, and especially from water likely to contain pond snails, which may be said to play the part of intermediate "hosts" in fluke development. For the larva of the fluke swims at first freely in water, and it is possible that this larva may be taken into the body of man, as into the body of the sheep, in the act of drinking. A very serious disease, however, may be caused by an animal also occupying a place in the fluke-group. This is the Egyptian blood-fluke, or *Bilharzia*, so called after a physician practising in Egypt, and who discovered this parasite in 1851. It is a curious parasite, measuring about half an inch or little more in length. The female is larger than the male fluke. The bloodvessels of the kidneys appear to be the favourite haunt of this parasite, and the eggs appear to escape from the ulcerated surfaces arising from the irritation produced by the parasite.

Passing now from the "flat" worms to the group of the "round" worms, several of which find in the body of man a habitat, we may briefly note two species which are tolerably well known. For example, a very common human parasite, is the "common round worm" or *Ascaris*, which inhabits the human intestine, and may attain a length of from 4 to 6 inches. It causes ill-health probably from the constitutional irritation induced by its presence. Another parasitic worm is the "small thread worm" or *Oxyuris*, from which children are apt to suffer so persistently. These latter worms do not bear any special relation to food. The manner in which they are acquired, in other words, is not so important as a question of health as it is one of personal cleanliness. Infection is probably direct—that is, the eggs probably pass from the digestive system of an already infected subject to be swallowed by another person.

There are, however, other "round" worms which bring us within the spheres of the physician, since they may cause serious disease in man. Of these the Guinea-worm (*Dracunculus*) is an example. This form is supposed by very good authorities to have been the fiery serpents of the ancient Israelites. Plutarch, at any rate, has a reference to "worms" infesting people on the Red Sea, and taking up their abode in the legs and arms of the victims. In all probability the young of this worm enters the body in water. It is especially common in India, and its habitat is usually the lower limbs. The head of the worm is found at the top of a swelling, from which it is extracted by being slowly coiled round some object. The essence of this operation is to avoid breaking the worm, inasmuch as, through that accident the eggs, of which the worm is full, may escape into the tissues and cause fresh irritation. The Negroes of the Gold Coast are said to be specially dexterous in the removal of this parasite, the young of which, long believed to exist in the form of the tank-worms, common in India, are now proved to pass their early stages within water-fleas. By drinking water containing these "fleas," the young Guinea-worm is located within the human body, and burrows its way towards the skin-surface of man.

With the name of the *Trichina* every one must by this time be perfectly familiar. Not so long ago our newspapers chronicled the fact that questions were continually being asked in Parliament concerning the nature of American pork and butter, which were supposed to have been affected with this parasite. It is an evident fact that many of our legislators would have been none the worse for a little training in natural history, to have enabled them to satisfactorily determine the nature of this bug-bear, the *trichina*, and of the disease which it produces, namely, *trichinosis*. The fact remains, at any rate, that a training in natural science is a valuable aid to a larger section of society than the world of zoologists and botanists. As a matter of deep social interest, the life-history of this animal is therefore of great importance, and, if I sketch it somewhat fully, it is because, of all parasites, it has perhaps the greatest interest for civilised man.

The *trichina* was discovered by Sir James Paget when dissect-

ing as a student in St Bartholomew's Hospital in 1834, and in 1835 Professor Owen described and named it *trichina spiralis*. The latter name refers to the spiral fashion in which each *trichina*

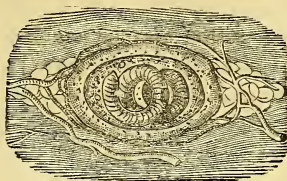


Fig. 6.

Immature or young *Trichina* coiled in its cyst in muscle (magnified).

(fig. 6) lies coiled up within a small bag or cyst. As seen in the human muscle or flesh, these *trichinæ* appear as mere white specks. The average length of the male worm (fig. 7) is about the eighteenth



Fig. 7.

Mature Male *Trichina* (magnified).

part of an inch long ; but the female (Fig. 8) is larger, being about the eighth of an inch long, whilst the capsule or cyst in which it is

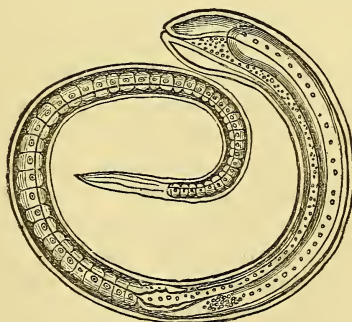


Fig. 8.

Imperfect Female *Trichina* removed from muscle, showing eggs in interior (magnified)

contained is about 178th part of an inch long, and the 130th part of an inch broad. The importance of a knowledge of the *trichina's*

development consists in such information supplying us with the best safeguard against infection. The proverb that "knowledge is power" receives no more apt illustration indeed, than when applied to the case of parasites, and to the zoological history which shows how infestation may be avoided. The male *trichina* may be distinguished from the female worm by a forked appendage in which the tail terminates, but the body of the latter is stouter than that of the male. A very large portion of the interior of the body in the female worm (fig. 8) is occupied by the egg-producing apparatus, and here, as in the tape-worm, we have to note the extraordinary fertility of the parasite. I am certainly speaking within, rather than over, the limits when I say that each mother *trichina* is capable of producing, at the very least, from ten to fifteen thousand young. These young are further produced *viviparously*; that is to say, the eggs are hatched within the parent body, and the young pass from the parent ready to enter upon their further development.

A preliminary observation may be said to contain the key to the whole history of the *trichina*. It is this: that, as we find the *trichina* existing in the muscles of the pig (fig. 6), they are immature. In this stage, each *trichina* is incapable of producing young. Suppose, however, that a portion of the infected flesh is eaten by man, then, as in the case of the tape-worm, the *trichina* falls on its feet, as it were, and it rapidly advances towards the perfection of its kind. They are capable of living from four to five weeks within the human digestive system. But within the second day after they have been swallowed by man they may become perfectly matured; their reproductive energies are perfected, and then ensues a marvellously rapid increase of the race. Each mother-*trichina* within the human digestive system, is capable of producing her thousands of young; and if we consider that these parent *trichinae* themselves may number perhaps hundreds or thousands, we may understand, in a new sense, the old sayings concerning the strength of united effort and the power of little things when multiplied to form their cohorts and legions.

What, then, is the next process that ensues? The horde of minute young now begins to migrate from the stomach to seek a

resting place in the muscles or flesh of the individual. They resemble somewhat the youthful tape-worms in this respect. For this purpose the whole brood burrows its way from the stomach to the different muscles; and it is during this process of migration, and whilst the parasites are wandering from the stomach to the flesh, that the serious nature of the trichina-disease becomes apparent. For the patient then becomes afflicted with pains compared with which, the proverbial tortures that afflict the just are as nothing. The excruciating pains which attend the migration were amongst the first symptoms noticed in this disease. In a severe case of trichinosis, the disease goes on from bad to worse, and ultimately the patient's whole body becomes literally disintegrated, delirium ensues, and the patient dies in a state of extreme exhaustion.

But, in a case of milder type, the pain ceases whenever the young trichinæ has arrived at their home in the muscles. If the patient's strength can but hold out until the young trichinæ settle down in his flesh, he then may be said to be safe. There, each young trichina surrounds itself with a small cyst, such as we saw the parent (fig. 6) to possess; and no further development of these young can take place, unless, indeed, cannibal tendencies should be developed, when transmission of the young brood to the stomach of another individual would perfect them for reproduction, and would result in the development of a fresh generation of young. The last scene in the life-history of the trichina in man is extremely interesting. After the trichinæ have become encysted in the muscles for some months, each trichina exhibits a process of degeneration. It then becomes a mere speck of lime deposited in the muscular tissue. It is in this degenerated state that the trichina is most frequently met with in the human subject in the dissecting-room. How, it may be asked, does the pig get the trichinæ which inhabit its muscles, and which must have migrated from its digestive system, as their young will migrate in man? For the pig must have swallowed the parent trichinæ, and must also have suffered from the trichinæ disease. It is believed that the rat is the source from which the pig gets its trichinæ; and in all probability, the circle of development may be said to be completed

by the rat in turn obtaining it somehow or other from man or from any other "host" of these parasites. As regards the number of trichinæ which may be contained within an animal, it is calculated that within a single ounce of flesh in an infected cat upwards of 325,000 parasites were contained. It has been calculated, also, that in an infected man, upwards of 40 millions of trichinæ may be present. Dr Cobbold tells us that in an ounce of pig's flesh 80,000 trichinæ were present; and he adds that the consumption of a pound of that flesh would give to man something like 400 millions of these "lodgers and boarders."

Our own country, happily, is almost entirely free from trichina disease. But on the continent, and especially in Germany, where the habit of eating uncooked pork or smoked pork is general, this disease is tolerably frequent. At first, indeed, the cause of this disease was so obscure that the cases gave rise even to ideas of poisoning; and it was only after the discovery of the trichina, and after the scientific investigation of its natural history, that the true nature of this disease was made known.

The time, however, has now come for a summary of the conclusions to which our studies naturally lead. I trust you have not been altogether horrified with these scientific details without at least some salutary effect following upon this process of laying bare the information and knowledge which usually remains in the possession of the naturalist and physician alone. I think I can sum up the health aspects of the subject in six axioms or pieces of useful information, the practical value of which I must leave to your own common sense to enforce.

Thus, firstly, we must insist upon all meat being thoroughly cooked, and the word "meat" ought to include fish. The reasons for these precautions follow upon your previous studies of to-night. First of all, from uncooked pork we obtain the pork tape-worm (*tænia solium*), and from underdone meat, the beef tape-worm; whilst from uncooked fish, man may get the broad-headed tape-worm (or *bothriocephalus latus*), and from uncooked pork we may receive a deadly cargo of trichinæ. It is interesting to know that we can appeal to actual experiments by way of proving

the accuracy of the advice which tells us that by means of thoroughly cooking our meat at a *high temperature* we may enjoy an absolute immunity from these parasites. A temperature of 140° F. has been estimated by the highest authorities to be that which no parasitic life can survive. If any one ate a piece of trichinised flesh—although it might, perhaps, be a rash experiment—which had been kept at this temperature for some length of time, he would in all probability escape the trichina infestation. Lesson the first is, therefore, one which advises us to cook our meat thoroughly, and to eschew a taste for underdone meat of all kinds.

Secondly, an equally important precaution is that of washing thoroughly all raw vegetable products. The reason for this piece of advice becomes clear when we reflect that we thus protect ourselves from the eggs of tape-worms, including the eggs of the dog's tape-worm which produces "hydatids" in the human liver. Even fruits, and especially such as have been picked up from the ground, without preparation may contain the germs of parasitic life. Raw vegetables of all sorts, such as lettuces and the like, used for making salads, for example, should be carefully washed to avoid danger.

In the third place, we should never drink water from any suspected or likely source of infection. By such sources I mean the water of canals and ponds, or of any brook which contains large quantities of vegetable matter, or which may harbour water fleas and water snails. From these latter animals we may obtain the young of certain tape-worms, and likewise the embryos of the liver fluke.

Fourthly, care must be taken of the general health. It is very important to remember in this connection, that parasites require a special soil for their growth, just as plants and animals at large require their special surroundings. And, therefore, other things being equal, these parasites are less likely to thrive in an individual whose general health is good, than in a subject of feeble constitution.

Fifthly, we ought to have—in so far as "hydatids" are concerned—special care of our dogs. Humanity to the dog is

perfectly compatible with keeping the dog at a respectful distance. The Icelandic practice of living on equal terms with our canine friends, results in the continual presence of "hydatids." The dog is happy and man safer when the former is relegated to his proper sphere—that of man's friend, but not his bedfellow or co-tenant of his room and sharer of his cup and platter.

Sixth and lastly, the old view of the "sanctity of dirt" has certainly no application to the modern question of parasites. Strict attention to every detail of personal cleanliness, is at once the beginning and the end of the advice which shows us the way of escape from the subtle foes that everywhere environ our lives.

In bringing this discourse to a close, it may be well that I should refer to one or two points connected less with the sanitary aspects than with the scientific side of my subject. If I offer, by way of conclusion, a few remarks upon the purely scientific questions involved in the discussion of parasites and their history, you may be the better enabled to reflect upon the causes which have wrought out the singular relationship we have seen to exist between parasites and their hosts. I presume no reasonable person would dream of maintaining for a single moment that these hosts were created complete and perfect, with the parasites dwelling in their interior. Such an idea, if entertained at all, can only present itself as the legitimate outcome of an absurd theology, or of an equally childish and unreal conception of the constitution of living nature. Such an idea, moreover, is contrary to evidence of the most positive character, which assures us that parasitism, both as regards host and guest, is an acquired and not an original condition. It is the result of laws and conditions of life's development which are everywhere and at all times in operation around us—modifying universally the worlds of life, from the humble lichen to the stately pine—from the monad-speck, that hovers on the twilight of animal existence, to the occupant of the human estate himself. We can thus trace all degrees and gradations of the parasitic life, and we may follow it from cases in which there is mere association, to those in which lodgment alone is obtained within or upon the body of the host. We are led from these illustrations to examples in which the

association has become of a closer kind; in which the parasite, originally free, has become wholly dependent on its host; and in which organs and parts useful for nourishment, for movement, and for other functions have grown "small by degrees and beautifully less," until the parasite appears as the degraded product of an acquired and secondary existence.

There are abundant examples and proofs to be found in the animal world of the originally free condition of the parasite. Think of *Sacculina* (fig. 1), the "guest" of the crab, which begins life as a free-swimming, six-legged water-flea, but which ends its life as the sausage-like bag whose roots, interwoven into the liver of its host, serve to feed its worse than vegetative existence. So also the life-history of a tape-worm and of a fluke equally present us with a notable clue to the original history of the parasite race, in the free condition of the young, and in the curious migrations through which these forms pass. If, therefore, the subject of parasites can teach you any lessons of wider application than mere sanitary cautions, valuable enough in themselves, I should say that you may be led from a study of the mere "why" of the subject towards some clear conceptions of a rational philosophy of the living beings—a philosophy which teaches that the ways of nature are everywhere hedged about with the conditions that produce continual change and variation in the children of life. As parasitism has been a growth and not a special creation, we may likewise discover that the cure and repression of this condition is really a matter of bettering our surroundings. As certain environments produce the soils and constitutions wherein parasites flourish and grow, so other environments check their growth and extirpate their race. The philosophy which teaches you the manner of their growth and development, likewise includes the knowledge on which to found their cure.

Last of all, in a day and in an hour when morbid sentimentalism fetters the hands of an unselfish science seeking but the advancement of truth, and the safety, welfare, and happiness of man, as well as the health of lower animals, you may be prepared to recognise that our immunity from the parasitic diseases that literally walk in darkness to slay us, is largely due to the just, legitimate,

and reasonable sacrifice, in scientific investigation, of a few of our animal neighbours. You have heard of the fatality of certain parasitic diseases, and you will admit the desirability of saving the life of man and the lives of animals from such a fate. Yet I warn you that in making that admission you are taking the first step on a course which, if certain philosophers of both sexes are to be believed, will lead you to the antipodes of all morality and of religion itself. For the only means whereby we can discover at once the history of parasitic development, and the means of cure, consist in the sacrifice of animals to the artificially-induced parasitic disease. Over and over again, the most valuable results in the discovery of the where, whence, and how of dangerous parasites, have been obtained by the administration, to dogs and other animals, of the parasitic embryos. Our knowledge of the way of escape from the deadly "hydatids" of liver and elsewhere, and the knowledge which warns us against the fatal trichinosis, has been obtained in either case by the sacrifice of lower animals. Let me ask you who hold the power to make and to repeal laws in your hands, if the sacrifice of the lower to the higher life was not, and is not, more than justified in such a service? And when the hysterical wailing of a certain section of the public is heard in our courts and temples, lamenting the often theoretical pain to which lower existence has been subjected, you may perchance, with some echoes of this lecture ringing in your ears, reply, and reply boldly, that science has been more than justified in her unflinching pursuit of that saving knowledge, which, followed up through the pain and suffering of the lower form, rescues man from the confines of the dark valley and saves him from the "nameless terror" of his race.

THE BRAIN, AND ITS FUNCTIONS.

BY DR J. BATTY TUKE.

I HAVE but scant time for introductory remarks. When I arranged to deliver one of this course of lectures, I was duly warned by the excellent lady to whom we are mainly indebted for their institution, that my audience would be such as would not be content with the mere enunciation of dogma, that every statement would need to be substantiated, that to each commandment reasons must be annexed. And when I sat down to think seriously over what I was to say to you, I very soon discovered that were I to talk merely of what was good and what was bad for the brain, I should be only cataloguing facts and opinions, which you, in the abstract, were as well acquainted with as myself. This would have been easy to do, and we might have wiled away an hour in general talk. But I conceive it to be the object of this course of lectures to place before the public the fundamental facts and theories which influence the physician in his endeavours to prevent and to combat disease. These facts and theories are all based on the sciences of anatomy and physiology—the institutes of medicine. Starting on the assumption that you are entirely unacquainted with the anatomy of the brain, and that your knowledge of its functions is confined to a general abstract belief that it is the organ of the mind, I felt it would be only talking round the subject if I did not, in the first instance, present to you some of the leading facts connected with its structure and functions. This, then, is not to be, strictly speaking, a Health Lecture; it is to afford a basis for a discourse on Brain Health, which I hope to deliver to you on a future occasion, should what I lay before you to-night be found to possess such intrinsic interest as to induce you to return. I must beg your

indulgence in dealing with a very large, intricate, and difficult subject; I can only hope to produce to you a very few of the most important facts. Had I to deliver six, instead of one lecture on the subject of the brain, my task would be comparatively easy—but if I can convey to you, within the next sixty or eighty minutes, some knowledge which you do not at present possess about this magnificent organ, my object will be gained.

Distributed throughout the whole system, pervading every tissue, except bone and gristle, there is a system of thread-like organs called nerves. In the skin and muscles, the nerves are in the form of small fibrils of a white colour. As we trace them upwards, we find these fibres coming together, forming bundles which grow larger and larger, as bundle joins bundle, until they form great nerve trunks, which pass into the spinal cord. The function of these nerves is to convey impressions *to* the spinal cord and the brain, and to convey *from* the brain and spinal cord the stimulus generated in those organs productive of motion. As I must circumscribe my subject it will be necessary to confine ourselves almost exclusively to this class of nerves, leaving almost unheeded the nerves of special sense, *i.e.*, those of the nose, eye, ear and tongue, and also to leave unmentioned those related to the great internal organs. Although we will thus be shut off from many questions of deep interest we will have little enough time to devote to the consideration of the connection of the spinal nerves with the brain and to the arrangement of the tissue of that organ and of the spinal cord.

The brain and spinal cord is composed of nerve fibre, nerve cells, connective tissue, and blood vessels. Their substance is a soft semi-fluid mass, the brain, for instance, contains 75 per cent. of water, only 25 per cent. being animal matter. In the spinal cord there is less water. The spinal cord is contained in the canal of the backbone; the brain in the great cavity of the skull called the *cranium*, or brain case. The spinal cord gives off for the supply of the trunk and extremities thirty-one pairs of nerves, which pass out by as many holes in the backbone, and those from the brain, with the exception of those going to the eyes and nose,

emerge from the skull at its base by similar perforations. Notwithstanding these holes and the great hole for the passage of the spinal cord, the brain case is hermetically sealed by muscles and other textures, so that no ordinary impulse from without can have any influence on its contents. Let me illustrate this. When I fill a glass jar with water, and inverting it under water, raise it above the surface, the water does not descend, the glass jar remains full; water may be forced out by the introduction of any body, but when that body is removed water returns. This represents the condition of the contents of the skull, which, whatever may be their difference in quality, must always remain the same in quantity. The bearings of this remark will be seen further on.

Each nerve is, as I have already said, composed of bundles of fibres, and each fibre is composed as follows,—first, internally, a delicate thread, called the *axis cylinder*, which is believed to be the medium through which impressions are conveyed to and from the nervous centres. This is surrounded by a white substance named, after its discoverer, the *white substance of Schwann*; and externally, a fine membrane of connective tissue, which is simply for the protection of the inner tissues.* Now, mark how closely the structure of a nerve resembles that of a submarine telegraph cable. A telegraph cable, as you see, is composed of a core, the copper wire which, as you know, conducts the magnetic current,—this corresponds to the axis cylinder; second, a layer of gutta-percha, for the purpose of insulating the wire, that is to say, for preventing the access of any body which might divert the current,—this corresponds to the white substance of Schwann; and third, a parcelling of yarn for the purpose of protecting the gutta-percha,—this corresponds to the fibrous protective membrane. There is, however, a difference between the nerve fibres outside and those inside the back-bone and skull; the latter are not invested with the fine external fibrous membrane. They are protected by a connective tissue peculiar to the spinal cord and brain. This

* Connective tissue is applied to the structures which simply bind together the component parts of the various organs, and serve as a support for delicate tissues.

connective tissue, termed *Neuroglia*, or nerve-glue, is difficult to explain to a non-professional audience. It is an extremely delicate reticulated net-work of fibres pervading the whole organ. When I say you can figure it best to yourselves by supposing that this mass of tow represents a portion of brain connective tissue, (nerve-glue is a bad term, as it conveys the idea of an adhesive substance), and that these wires represent the nerve fibres, and these tubes the blood-vessels supported by it, you must remember that it is a tissue so fine and delicate that it can only be seen by the use of a very powerful microscope. I may best illustrate the coarseness of my illustration by saying that, were this tow and these wires a piece of an actual brain, the brain itself would be at least the size of the Castle rock. The nerve fibres of the brain and spinal cord are very delicate, varying in diameter from $\frac{1}{40000}$ th to $\frac{1}{120000}$ th of an inch, and, of course, are utterly inappreciable by the unassisted vision. There remains the nerve cells to be described—these are the most important organs of the nervous system; but I think it will be better to delay their consideration until I have described more fully the general anatomy of the brain and spinal cord.

The spinal cord is from fifteen to eighteen inches long; it is divided into two equal lateral halves by two fissures which nearly meet; it communicates with the brain through the great hole at the base of the skull. Throughout its whole length nerve fibres extend, but their arrangement is different in the front and the back portions of the organ. In the back portion of each half, or posterior columns as they are termed, as each nerve enters the cord a considerable number of its strands cross over to the opposite side and run upwards to the brain. The function of this part of the cord is to carry to the brain sensations generated in those parts in which the nerves are distributed, or to use the convenient scientific term, from the periphery. In the front, or anterior columns, the fibres pass upwards on the side they enter, and do not cross till they reach the medulla oblongata, the organ which connects the spinal cord with the brain. Their function is to carry messages from the brain to the periphery. The posterior or sensory nerves, and the anterior or motor nerves, are

separate for some short distance after leaving the cord ; but they then join and pass out from the back bone as one nerve, which has the power of transmitting messages upward and sending messages downwards.

I think I have said enough in the meantime about the anatomy of the nervous system to allow me to proceed to the description of the brain, which is its great dominant organ. The model I hold in my hand represents the organ exposed by removal of the skull—you see it looks as if enveloped by a bladder—this membrane is called the *dura mater* or tough protector ; immediately below this is a very fine membrane called the *arachnoid*, its extreme delicacy suggesting a spider's web ; and next to the brain itself is another fine membrane called the *pia mater* or soft protector, which invests it very intimately. All these membranes pass through the great hole at the base of the skull to envelop the spinal cord. This second model represents the brain divested of all its coverings except the internal one, and this third one a brain perfectly exposed. In this condition its average weight in man is nearly 3 lbs., in women some ounces less ; this difference is not to be explained by the smaller stature and bulk of women, for it has been shown that whereas the brain weight is nearly 10 per cent. less in woman than in man, the stature is only 8 per cent. less. It was supposed by Sir William Hamilton and others that the brain reached its full development as to size at the age of seven, but this idea is now entirely abandoned, and it is generally held that it does not reach its maximum weight till the twentieth year. It is true that in boys it arrives at fully $\frac{5}{8}$ ths of its weight by the seventh year, and in girls $\frac{1}{2}$ ths, which may, to some extent, account for the greater precocity of the latter, but the change which goes on in its constituents during the development of the remaining $\frac{1}{8}$ th and $\frac{1}{2}$ th, between the years of seven and twenty, are of a most important character. I had intended to speak of the statements lately made in certain journals as to the alleged diminution in size of the head within the last fifty years, but the fallacy of those statements was so thoroughly exposed in last Monday's *Scotsman* that I deem it unnecessary to reiterate the

arguments. I consider this article of so much importance that I purpose republishing it with this lecture.

The great anatomical divisions of the brain are not difficult to demonstrate. As I hold the model in my hand with its upper surface exposed to your view, you see a great mass of twisted and apparently irregularly arranged matter of a greyish pink colour, and when we examine the base of the organ we see the same type of arrangement existing there, except at the lower and back part of it, where we have a striped double mass. The upper twisted convoluted organ is the *cerebrum*—the great brain—the brain, and the inferior small striped organ is the *cerebellum* or little brain. You will notice a long mass projecting in front of the cerebellum, this is the *medulla oblongata* or oblong marrow (oblong in contradistinction to the long round spinal marrow); it is continuous with the spinal cord; and in front of it a transversely striped mass, called the *pons Varolii*, or Bridge of Varolius. I shall avoid technicalities as far as I am able, but for our mutual convenience I must ask you to remember the four terms—*cerebrum*, *cerebellum*, *medulla oblongata*, and *pons Varolii*. When I remove the three latter organs you will see at a glance how thoroughly the great brain deserves its name; it is with this organ, the cerebrum, that I have mainly to do to-night.

The cerebrum is divided into two equal halves by a great fissure called the *great longitudinal* fissure; these halves are called the *hemispheres* of the brain. These are made up of apparently complicated structures, convoluted worm-like organs which twist and turn over its entire surface. But in point of fact the arrangement of these organs, which are called the *convolutions*, is pretty definite, and the anatomist has by careful study been able to arrange them into divisions or *lobes*, and to assign to each convolution a separate name. Moreover, the physiologist and pathologist have noted phenomena which point to different functions being localised in certain areas.

I will not go further at present into the nomenclature of the divisions of the brain than to state to you that the anatomist speaks of the *anterior*, the *middle*, the *posterior*, and the *temporo-sphenoidal* lobes.

The convolutions dip deeply into the substance of the organ;—this you cannot see in a model, but if you look at this brain which has been hardened in spirit, you will notice that they form deep furrows. On the depth of these furrows, and on the tortuosity and complexity of the convolutions is believed to depend, to a very great extent, the potentiality of high intellectual development; for in the brains of the inferior races of mankind the convolutions have been found very simple and shallow, whilst in those of distinguished men they have been generally observed deep and complex; and as we watch the scale of intelligence in the lower animals we find complexity of brain arrangement as we ascend. The purpose of the convolutions seems to be the extension of superficies on which to extend the more active structure of the brain, viz., the grey matter.

When we slice off a portion of the brain and expose its interior we notice a very distinct and definite difference in the appearance of its structure. There is a great central mass of a glistening white substance which is bordered all round by a layer of pinky grey matter which dips into the fissures and into all the furrows between the convolutions—it is about $\frac{1}{2}$ an inch in thickness. The difference in colour between these two matters is due first, to the much richer supply of blood to the grey than to the white matter; and second, to the presence in the grey matter of those most important bodies the *brain cells*. Both matters are composed of blood vessels, neuroglia, and nerve fibre, but *nerve cells exist only in the grey matter*. These bodies which are found in incalculable numbers, probably in hundreds of thousands, vary in size, but the largest of them is invisible to the naked eye; they consist of finely granular protoplasm, i.e., the simplest form of matter known to science; they vary somewhat in shape, those of the brain being mostly globular or pear shaped, appearing triangular when cut through lengthwise; those in the spinal cord being irregular in shape, presenting this appearance under the microscope (fig. 1). Each contains a *nucleus* or kernel, which again contains a *nucleolus* or little kernel. They are arranged in layers of from four to six in number and are supported in position by the neuroglia. I have twice used the adjective “most important” when speaking of

these bodies ; and, for this reason, we have the best reasons for believing that they are the organs through which impressions from

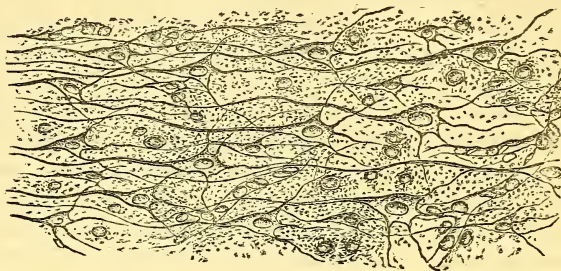


Fig. 1.

without are appreciated, that through their vital properties we see, taste, hear, smell, and feel, and that in them is generated and stored up what we, in our ignorance, term nerve force, and from them is discharged what we, in our ignorance, term nerve energy. For the purpose of immediate illustration let me adduce three experiments in confirmation of these statements—(1) When we irritate the surface of the skin a sensation of pain is produced which is referred to the part injured, but which really exists in the brain ; for if we cut off the nerve connection between the part and the brain no sensation is experienced however much the part may be irritated. The brain is therefore a perceptive centre. (2) When we *will* to move a limb, under ordinary circumstances the limb obeys the stimulus of the will and movement ensues ; but if we destroy any part of the nervous apparatus connecting the brain and the limb, no effort of will can produce action. The brain is therefore the organ of volition. In the first instance the results of irritation cannot be carried *up* to the brain, and in the second the stimulus of the will cannot be carried *down* to the limb ; (3) When the grey matter of the convolutions is removed or injured by extensive disease the subject of experiment becomes more and more dull and stupid until at last all indications of perception and volition disappear. Comparing it to an electric telegraph whose apparatus is at fault, in the first experiment

the indicating needle is useless ; in the second the manipulator may work the handles as energetically as he will, but without result, in both instances because the connecting wires are injured ; and in the third experiment the cells of the battery are removed.

Let us now inquire what is the arrangement of the connecting apparatus. As I have shown you, each hemisphere of the brain consists of masses of grey matter and of masses of white matter. The grey matter is arranged in *ganglia*, i.e., aggregations of nerve matter containing nerve cells. These ganglia are two-fold—1st, the grey matter of the convolutions forms two great ganglia called the *great hemispherical ganglia*, covering the whole surface of the organ, and 2nd, in the middle of the brain or rather nearer its base there is a series of such ganglia. The scientific terms applied to these are *optic-thalami* and *corpora striata* ; but I shall speak of them as the *basal ganglia*. The grey matter of these basal ganglia is in direct anatomical connection with the grey matter of the spinal cord, which differs from that of the cerebrum in that it lies in the centre surrounded by white matter. In the spinal cord the white matter is external. We have already traced the course of the fibres in the cord. Remembering that the function of the anterior fibres is downward and that of the posterior upward, we will, for the purposes of anatomical description, trace them from below upwards. In their course to the brain they are connected with the cells of the grey matter of the cord ; passing through the medulla oblongata, and pons Varolii, they run towards the basal ganglia, some of them passing right through, whilst others terminate in the great nerve cells of those organs, and are thus interrupted in their continuity ; but they start afresh to pass on with the uninterrupted fibres in their course to the grey matter of the hemispheres. From the basal ganglia the fibres spread out like a fountain, or like the sparks from a firework—they radiate, or are projected towards the dome of grey matter, and are in consequence termed the *corona radiata*—the radiated crown, the *projection series* of fibres. By this means we have direct communication established between the furthest extremities of a nerve and the hemispherical

ganglia. An ounce of demonstration is worth a pound of description in dealing with such a difficult subject, and I do not think I would have ventured to speak about it were it not that I had it in my power to lay the actual thing before your eyes. This I am enabled to do by the kindness of Dr Hamilton, Pathologist to our Royal Infirmary. This large slide contains a very thin section or slice of a human brain. By a marvellously ingenious process devised by himself, Dr Hamilton is able to cut a slice so thin as to permit of the passage of light, and therefore to cast on a screen the images of its various structures. What I am about to show you is a slice made through the entire substance of the organ as nearly as possible in the middle line from before backwards.

[Here a longitudinal vertical section of the brain was thrown on a screen 20 feet square, showing in detail what is seen in diagram No. 2.]

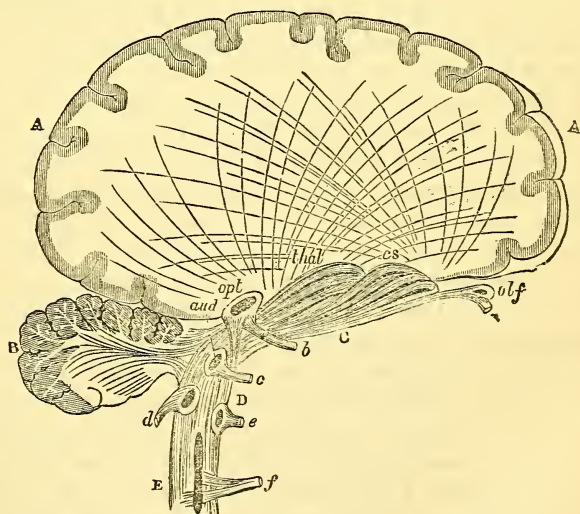


Fig. 2.

But you will ask how does fibre communicate with cell, Looking at this model of a cell we see that it has various filaments

projecting from it; these are called the *Poles*. Cells are termed *unipolar*, *bipolar*, and *multipolar*, according as they possess one or two or many projections (see fig. 1). The poles at the base are termed *basal*, those at the apex *apical*, and those starting from the sides *protoplasmic*. Now the basal pole is continuous with the axis cylinder of the nerve fibre, which I told you is the medium through which impressions are conveyed in the nerves. According to certain authorities the poles at the apex are continuous with a horizontal series of fibres on the surface of the convolutions, and it is also believed that cell communicates with cell by means of the protoplasmic poles.

So much for the connection of the brain with the rest of the nervous system; but we must revert to the models again for a few minutes to show another important connection, that between the two hemispheres. Every part of the nervous system is double: there is a right and left cerebrum, cerebellum, medulla oblongata, and spinal cord, and each of these lateral halves is in direct communication with the other. The nervous centres are double organs, and are associated together by nerve-fibres. I ask you to accept this statement as far as it concerns the other organs, but I am able to demonstrate it to you in the case of the brain by another of Dr Hamilton's wonderful sections. Deep as the great longitudinal fissure is, it does not cut the cerebrum entirely in two. At the bottom of the cleft there is a mass of transverse fibres called the *corpus callosum*, or hard body. This is the most important commissure of the brain. The derivation of the word commissure, *committo*, to bring together, indicates its function. Through it pass nerve-fibres which can be traced from the grey matter of each hemisphere, bending in the form of an arch (and therefore termed *arcuate* fibres), to the corpus callosum, passing through which, they course to the grey matter of the hemisphere opposite to that they start from, and reach it at an exactly corresponding spot—identical portions of each hemisphere are thus connected.

(Here a transverse vertical section was shown, illustrated by diagram No. 3).

Thus we have, by means of nerve-fibre, a perfect system of

association—by the radiating fibres the spinal cord is in direct connection with the cells of the grey matter of the brain, and by

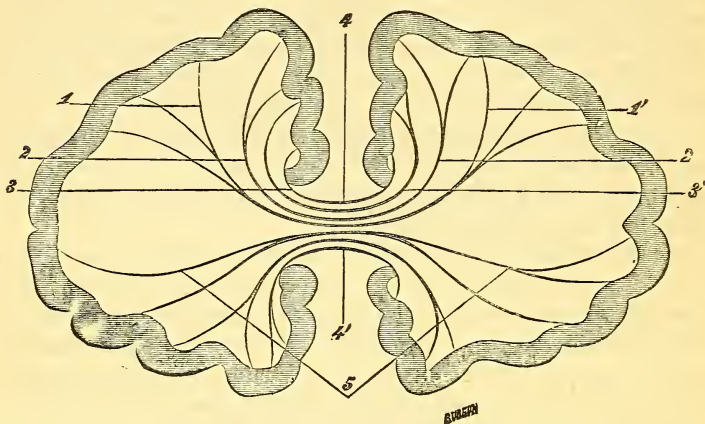


Fig. 3.

the arcuate system the cells of opposite hemispheres are brought into intimate relation one with the other.

I will now direct your attention to the blood-supply of the brain. From its constant activity, the brain demands a large amount of blood to nourish and restore its elements. In point of fact, nearly 6 per cent. of the total blood is at work in the brain: and if we consider that about 64 per cent. of the blood is circulating in the heart and large vessels, and only some 36 per cent. in the tissues of the body, we gain an idea of how richly the brain is supplied. Time will not permit of me going into the interesting subject of the arrangement of the brain blood-vessels. Suffice it to say that it is devised with the objects first of insuring not only a very copious supply, but also a very uniform and equal flow of the nutrient fluid, and secondly, of protecting it, as far as possible, from influences from without. The results of the stoppage of a cerebral vessel are most disastrous—the functions of the part supplied are at once arrested, and unless the obstruction is removed the tissues become permanently disorganised. The con-

volutions are nourished by vessels which enter from their outer surface, certain of which pass on to the white matter. But the blood-supply is five times greater to the grey than to the white matter, an additional evidence, if such were necessary, that the former exercises much more functional activity than the latter.

You will remember that I pointed out to you at the opening of this lecture that the brain is contained in a hermetically sealed cavity of rigid bone, and that the quantity of matter in this cavity must always remain the same. Now, unless some provision exists for differences in the amount of blood in the brain, it follows the amount of blood must remain invariably uniform. And this was for long believed to be the case. But experiments have shown that this is not true, that, although the total amount is pretty uniform, still, under certain circumstances, the quantity of blood varies. This is markedly so in the condition of sleep—it has been reduced to demonstration that during sleep the amount of blood in the brain is diminished. How, then, is compensation procured for the withdrawal of blood, and what material is displaced if a greater quantity than usual is introduced? This compensation is procured by the *cerebro-spinal fluid*. You know the brain contains 75 per cent. of water: under circumstances of blood-pressure, a certain portion of this water becomes rapidly absorbed or displaced, and when blood is withdrawn a portion corresponding in bulk to the abstracted blood is rapidly drawn into the cavity of the skull. "Hence we may consider that the cerebro-spinal fluid in the interior of the skull not only subserves the mechanical functions of fat in other parts as a packing material, but, by the readiness with which it can be displaced, provides the means whereby undue pressure and insufficient supply of blood are equally prevented" (Kirke's Hand-Book of Physiology).

The consideration of the chemistry of the brain will not detain us long, for really not very much is known about it. The nervous tissue contains substances closely allied to albumen, which, as you know, is the chief constituent of the white of egg, a substance which coagulates when mixed with alcohol. But I do not think any physiologist would venture the statement made by a dis-

tinguished teetotal lecturer last year in this city, that these albuminous substances contained in the brain become coagulated by the drinking of spirits. Were it true that when alcohol is introduced into the system the albumen of the brain coagulates, the brains of a very large proportion of our countrymen would be in a condition identical with that of hard-boiled eggs; and although the Scot is generally regarded as a hard-headed man, his hard-headedness hardly amounts to this. The lecturer I allude to reduced his statement to demonstration. He placed in a glass vessel a certain quantity of white of egg, which he told his audience was identical with certain substances contained in the brain. He then poured in a glass of whisky which, of course, produced coagulation, and he drew the deduction that the same result obtained in the brain when it was under the influence of alcohol introduced into the system through the stomach. It is a pity that a good cause should be marred by such misrepresentation. Supposing I were an anti-teetotal lecturer, I could equally easily, and equally inaccurately, quote chemistry for my purpose in denouncing tea. I should say to you:—"Ladies and Gentlemen,—Dr Foulis in his lecture last year on the blood told you that it contained a considerable amount of iron. You are in the habit of thinking tea is a harmless beverage, but mark this experiment:—in this jar of water is a small quantity of a solution of iron;—observe the dreadful results when I add to it a cup of tea—it converts it into ink by virtue of its tannin, and it acts in a similar manner on the blood!" I beg to assure you, however, that both statements are equally incorrect. Alcohol does not harden the brain, on the contrary, it softens it; and tea does not convert the blood into ink. I wonder if this lecturer would be surprised to learn that, do what we will, a true alcohol exists in every brain. In the nervous tissues of the most conscientious teetotaler an alcohol called *cholesterin* is to be discovered in considerable quantity. He would probably say that if such is the case there is no reason for adding more, and, unless under exceptional circumstances, I am inclined to agree with him.

With this very rough statement of the anatomy and structure of the brain, we pass on to consider its functions. Certain of

these have been already alluded to. I am only going to speak of the functions of the cerebrum, leaving those of the cerebellum and the medulla oblongata either to another occasion or to another lecturer. The functions of the cerebrum are thus summarised by Kirke:—" (1.) The cerebral hemispheres are the organs by which are perceived those clear and more impressive sensations which can be retained, and regarding which we can judge. (2.) The cerebrum is the organ of the will, in so far at least as each act of the will requires a deliberate, however quick, determination. (3.) It is the means of retaining impressions of sensible things, and reproducing them in subjective sensations and ideas. (4.) It is the medium of all the higher emotions and feelings, and of the faculties of judgment, understanding, memory, reflection, induction, imagination, and the like."—"Handbook of Physiology," Kirke.) These conclusions have been arrived at (1.) by the observation of the facts of comparative anatomy, which show that as we ascend in the scale of the animal kingdom, with increased development of the brain we have an increase of intelligence, till on reaching man we find the most perfect type of brain; (2.) by the careful study of the symptoms of disease of the brain; and (3.) by experimentation. The subject of progressive development is most interesting, but I cannot allude to it further now than to point out the characteristic of the human brain which serves to distinguish it from those of the rest of the animal kingdom. This is that in it only the posterior lobes are so fully developed as to overlap the cerebellum. Even in the higher apes in which the type approaches most nearly to that of man, the back part of the brain is much less perfectly formed, and the cerebellum can be seen when the organ is viewed from above.

But the most definite proof that the cerebral hemispheres are necessary for the production of those phenomena which we term intelligence and will, is based on data procured by the observation of their injury by disease, or by the hand of the physiologist. Every one knows that a violent blow on the head produces unconsciousness, and that mental function is in abeyance when blood is effused on to or into the brain, producing apoplexy. But these

are but coarse experiments, and the physiologist has been obliged in order to elucidate important facts bearing on the treatment of disease to submit animals to experiment. He has found by this method that when the grey matter of the superior convolutions is removed, intelligence and voluntary movement are put an end to—that all spontaneous action becomes impossible. A frog, the upper part of whose brain has been removed, continues to breathe, and is even able to move his limbs when irritation is applied to them, through virtue of the functions of the spinal cord and medulla oblongata, which are themselves independent nervous centres—independent to this extent that they are able to transfer impressions from the posterior or sensory columns to the anterior or motor columns, without sensation being conveyed upwards to the brain, and yet motion being produced. This is termed *reflex action*. But as I have already stated to you, if the grey matter of the convolutions is destroyed, or if the connection between the brain and the spinal cord is severed, feeling cannot be experienced and the will becomes inoperative. I do not think it necessary to prolong the argument, as sufficient has been said to enable you to give a reason for your belief, that the possession of a brain is necessary for the manifestation of mental phenomena—that it is in fact the organ of the mind. What the nature of the processes is through which these phenomena are produced we are entirely ignorant. As Hermann says, “in a part of the central organs, the cerebral convolutions, certain material processes are accompanied in an inexplicable manner with wholly indefinable phenomena, which characterise what we term consciousness. The term mind may be applied to the combination of all the actual and possible states of the organism.”

Nothing is definitely known as to whether any of the mental functions are localized in any particular part of the brain. It is highly probable that such is the case; but science has not as yet been able to produce any substantial proof. You may feel quite certain, however, that the so-called science of phrenology is based on entirely fallacious data. The idea that the skull can be mapped out into small areas indicating the mental function of the subjacent brain, is entirely false. If we look at a brain

covered by its tough outer membrane we see that it is as devoid of irregularities on its surface as a bladder of lard ; and if again we inspect the inner surface of the skull cap we find that if it has any depressions they do not correspond with elevations on its outer table. The phrenological images which are still sold in the shops may be regarded as the Fetishes of an extinct faith. I wish I had time to tell you of the work which is being done by many earnest physiologists, who are striving hard to arrive at accurate conclusions as to the localisation of brain functions. It is a question of the utmost importance to medicine, and already many valuable observations have been made ; but so long as the physiologist has his hands tied by legal enactments the interests of the healing art must suffer and mankind with them. Let me remind you of what was once said by the highest authority in morals—"Ye are of more value than many sparrows."

I will only instance one or two of the results obtained in this direction. Fritsch and Hitzig in Germany, and Professor Ferrier in this country, have found that the stimulation of various circumscribed areas on the surface of the convolutions (which till lately was believed to be insensible to irritation) is followed uniformly by movements of particular limbs,—for instance, if a mild current of electricity is applied to one spot, the leg is moved ; if to another, the eyes ; if to a third, the neck, muscles of the face, and so on. Ferrier, indeed, has by patient inquiry mapped out the various areas which he holds to be centres from which, in the phenomena of voluntary movements, influences pass to special groups of muscles ; and he has continued his investigations in the direction of destroying these centres, and has found that paralysis of the muscles which contract on the irritation of electricity, is the result. I admit that this line of investigation was first suggested by the observation of disease. Broca of Paris noted the uniform coincidence of destruction of a small area of an anterior convolution of the left side with loss of speech ; but this observation merely opened up a field of inquiry most important in its relation to medicine and physiological science, which could not have been tilled if the physiologist had not submitted animals to experimentation, nor, in fact, could any of the

physiological facts I have adduced to you to-night have been verified or reduced to demonstration without vivisection.

In conclusion, allow me a few minutes to indicate the practical outcome of this lecture. Having now before you some of the great facts connected with the constitution and arrangement of the tissues of the brain as they exist in health, it will be all the more easy for you and for me to consider together on a future occasion the effects produced upon them by malign influences. My hope is that the demonstrations of to-night will help you to recognise the truth of the theorem, *that we have a right to presuppose that in the brain, as in other organs of the body, the normal exercise of function is dependent on a perfect maintenance of the anatomical relations of the component structures.* Believe me, this position is not by any means universally accepted; the world is only too apt to regard many of the phenomena of brain disease as mere perversions of function, independent of structural change: few men, for instance, appreciate that that most awful calamity, madness, is dependent on material morbid processes—that it is a disease. Lunacy is regarded more as a psychological curiosity than as an indication of a diseased condition. I expect to be able to demonstrate to you the structural nature of many of the morbid conditions which are produced by certain of our habits of life; and when I address you on the subject of Brain Health I shall feel something under my feet when speaking of the evil effects of neglected or of over education, of over work or of idleness,* of alcoholism, of over and of under feeding—“Brain cell,” “nerve fibre,” “neuralgia” will not be mere terms, but will convey to your minds something palpable; you will know that they are structures which may be put out of gear just as any other structure of the body may be; “nerve exhaustion” will not be a mere form of speech. There is perhaps no organ of the body over which we can of our own free will and accord exercise so much influence for good or for evil as the brain; we can to a great extent make it or mar it, and in marring it we mar the whole system, *for on the normal exercise of brain function depends the permanent exercise of the function of every structure of the body.* And remember this—the brain cannot, like the lungs, the liver, the

skin, or the kidneys, cast any of its functions on other organs—it is, so to speak, self-contained—it can gain no relief in disease from vicarious aid ; it must do its own work, rid itself of its effete matter and of the products of injury or disease, and provide within itself for the resumption of functions, the exercise of which has become impaired from whatever cause.

We see daily the evil effects of overstraining the powers of the brain. Many sources of overstrain are beyond our control. In the hard battle of life man must work hard to gain a living, and often under circumstances prejudicial to brain health. But mind you the brain is a long suffering organ as far as work is concerned. It is not work but worry that kills it, and worry is not an influence we can often keep in subjection. But it is in the power of many members of the community to kill the brains of others by overstrain. It is very doubtful economy to overstrain thews and muscles, it is very false economy to overstrain brain cells, for on the action of these cells the proper use of the muscles depends. When a man has to concentrate his attention his brain cells are actively at work—work implies loss of tissue and constantly diminishing functional activity ; therefore concentration of attention is limited. This is practically admitted in certain services—*e.g.*, the naval and military—in the former, a man's trick at the wheel does not exceed two hours, and in the latter the sentry holds his post for the same term. Except in time of war it does not very much matter about the soldier, but the sailor at the helm may, by a mistake, cause loss of life and property. Experience has thus demonstrated the physiological fact that, even under supervision of trained officers, human attention cannot, under ordinary circumstances, be relied on for more than a certain limited time when the safety of communities is at stake. But we are told this is disregarded in the service which most of all holds men's lives in its hands—the Railway service. We are told that railway servants are kept in the switch-cabin for many long hours at a stretch, wielding the instruments, the wrong use of one of which may wreck the train. This is an utterly unphysiological position in which to place any man, and the onus of evil consequences lies at the door of those who outrage the laws which

govern health. No individual or company can protect himself or themselves against the stupidity of mankind ; but given a proved attentive servant who has to exercise monotonous duties, on the accurate performance of which the safety of the public depends—given in fact the very best conditions—it is worse than unwise to press his powers of concentration for more than a very few hours at a stretch. Railway servants should keep watch and watch ; their trick at the switch, like that of the sailor at the wheel, should be two hours about. If under such circumstances they fail in their duty and kill men they may be held responsible—but not otherwise.

I wish you all good night, trusting that within the next two hours the supply of blood to your brains may be diminished, and that sleep will ensue in accordance with physiological laws, and that you will all rise strengthened by repose and ready to receive the health-giving influence of the God-ordained day of rest.

HEAD MEASUREMENTS.

The Scotsman, December 5, 1881.

The brain is universally recognised as the organ of mind, and the size of this organ is very generally taken as an index of mental capacity. Big brains have come to be suggestive of great minds, while it is an undoubted fact that the possession of a brain which falls below a certain minimum standard of weight implies idiocy on the part of its unfortunate possessor. M. Broca places the lowest limit of brain-weight compatible with human intelligence at 37 oz. in males, and 32 in females, the average brain-weight of Europeans being about 49 oz. Whether the possession of more than the average quantity of brain implies the presence of more than average intelligence is a question that has given rise to much discussion. It is an undoubted fact that very high brain-weights are occasionally found in people whose mental acquirements are certainly not above the average. Out of 157 brain-weights of adult Scotsmen, Dr Peacock found that four, all belonging to artisans, who, so far as could be learned, had not been distinguished above their fellows by superior intellectual endowment, weighed over 60 oz. each, while the heaviest brain on record—it weighed 67 oz.—belonged to a bricklayer. Dr Morris, who chronicled the case, was told that the man “had a good memory, and was fond of politics; but that he could neither read nor write.” Whatever his potentialities might have been, “it is evident,” says Dr Morris, “that his actual acquirements were not great.” The non-development of superior mental power in such cases may, however, be attributable not to lack of capacity for learning, but to the absence of the conditions necessary to its growth. Certain it is, that among the educated and intelligent

classes the number of big brains is greater than with uneducated and less intelligent people. Among the latter, the proportion of brain-weights above 55 oz. has been ascertained to be only from 4 to 6 per cent, while the proportion among men who have been distinguished for great intellectual acquirement is at least 23 per cent. The brain-weights of only 23 such men are accurately known, and it is from these that the above proportion has been obtained. With few exceptions, these were all above the average capacity of 49 oz. First in this respect comes the celebrated naturalist Cuvier, with a brain-weight of $64\frac{1}{2}$ oz., followed by the famous Scottish physician, Abercromby, and the poet Schiller, each with 63. Goodsir, the anatomist, follows at a considerable distance with $57\frac{1}{2}$, Sir James Simpson with 54, and Chalmers with 53. That such men as Gladstone, Bright, etc., possess more than average brain-weight may be inferred from a statement lately made public of the size of hat worn by these and a number of other living or recently deceased statesmen and litterateurs. Premising that what is known to the trade as size 7 is that of the average head, with presumably 49 oz. of brain, and that $7\frac{3}{8}$ is a size so large as only to be made when specially ordered, it appears that out of fourteen persons whose hat-sizes are given, two (Lord Chelmsford and Dean Stanley) were below, while other two (Lord Beaconsfield and the Prince of Wales) were exactly up to the average. Of the others, Dickens, Selborne, and Bright required $7\frac{1}{8}$, Earl Russell $7\frac{1}{4}$; Lord Macaulay, Gladstone, and Thackeray, $7\frac{3}{8}$; Louis Philippe, $7\frac{3}{4}$; and the Archbishop of York, 8 full! Of the twenty-three distinguished men already referred to whose actual brain-weights are known, four, including the late Professor Hughes Bennet, and Hermann, the philologist, were distinctly below the average, showing, as Dr Bastian points out in a recent work, that "a well-constituted brain of small dimensions may be capable of doing much better work than many a larger organ whose internal constitution is, from one cause or other, defective." When there is no such defect, however, the big brain, there is every reason to believe, confers an undoubted advantage on its owner.

Such being the case, it is not surprising that the assertion

recently made, that a sensible diminution had taken place of late years in the size of the heads of the male population of those islands, and consequently of the brains—for in health the brain always fills the skull—should have attracted attention. The data upon which this startling statement is founded have been supplied by the most persistent, if not the most scientific, class of head measurers—the hatters, whose evidence on the point is of the most circumstantial kind. One merchant, of large experience, states that of the six sizes of hats beginning at 21 inches, and increasing by one-half inch to $23\frac{1}{2}$ inches, he was in the habit, five-and-thirty years ago, of buying for his retail trade in the following ratio, beginning at 21 inches—viz., 0, 1, 2, 4, 3, 1, while at the present time he is selling hats in the following ratio—viz., 3, 4, 3, 1, 1, 0. In other words, where only one hat was required, thirty-five years ago, at or under $21\frac{1}{2}$ inches he now requires seven; and where formerly four of the two largest sizes were required, he now only needs one. From numerous letters which have appeared in *Nature*, the experience in this instance would appear to be that of the trade generally. One manufacturer writes—"I should say that heads generally are two sizes less than at the time (thirty to forty years ago) you refer to; a head of more than 24 inches circumference is now quite a rarity, whilst we make thousands of hats for heads with a circumference of about 21 inches." The decrease, according to another manufacturer, is so general "that we do not make big-sized hats for stock, but only as ordered, and very few then." That a similar diminution has taken place in Scotland is the experience of one of the principal hatters in Glasgow. There can be no reasonable doubt, therefore, that our hats are, on the whole, smaller than they were a generation ago; do smaller hats, however, in this case imply diminished heads? It has been pointed out that the undoubted diminution is probably to be explained by a reference to change of fashion in the mode of wearing both hat and hair. Thirty years ago it was customary, as the prints of the time show, to wear the hat drawn well down over the head how far over may be judged from the fact that it was customary, in England at least, to attach a piece of cloth to the under side

of the brim at the back in order to take the friction off the coat-collar. On the other hand, the hair was worn thick and long, the present style of close-cropped hair being in those days associated with soldiers and prisoners. These two causes together seem fairly adequate to explain such decrease in the size of hats as has been noticed. If inadequate, as certain correspondents in *Nature* maintain, the only alternative is to believe that, in the course of little more than a quarter of a century, the heads, and consequently the brains, of our male population have sensibly diminished. That this is in the last degree improbable will be the opinion of every student of recent anthropological science.

In a progressive civilisation such as prevails in this country and throughout the greater part of Europe and America, there is reason to believe that the cranial capacity of the population is, on the whole, increasing rather than diminishing. Owing to the want of early observation, it is difficult to institute comparisons between past and present. An opportunity, however, lately occurred in Paris which was taken advantage of by M. Broca. In digging the foundation of a new building a vault was opened containing a large number of human skeletons, whose surroundings proved them to have lived not later than the twelfth century. M. Broca found the average capacity of 115 of those twelfth century skulls to be 1426 cubic centimeters; while another series of skulls—125 in number—taken from a cemetery belonging to the early years of the present century, gave an average of 36 cubic centimeters more. The average Parisian skull would thus seem to have increased considerably in capacity during seven centuries of progressive civilisation. That this increase has gone on slowly but surely as man progressed from barbarism to civilisation may be inferred from a study of the cranial capacities of the various human races. Thus, while the brain capacity of the European amounts to 94 cubic inches, it is only 91 in the Esquimaux, 85 in the negro, 82 in the Australian, and 77 in the Bushman. These are merely averages, and, as such, do not bring out the important fact lately noticed by Le Bon, that among the lower races the limits of variation in the cranial capacity of individuals of the same sex

are much less extended than in the higher races. Thus, among modern Parisians large and small skulls vary by about 600 cubic centimeters, while negro skulls vary only by 204, and ancient Egyptian by 353 cubic centimeters. Another important difference in the cranial capacity of the higher and lower races is connected with sex, and serves to throw light upon the influence of mental exercise in increasing brain capacity. According to Professor Bischoff, of Munich, in a recently-published work, the difference between the average brain-weight of men and women is $10\frac{1}{2}$ per cent. Much of this is undoubtedly due to difference in stature, a tall person having, *cæteris paribus*, a larger brain than one less in height; partly, however, it is attributable, there can be little doubt, to inferior mental training. Among the lower races, where the women have not only charge of the offspring, but have also to share, and that largely, in the husband's occupations, the brain capacity of the two sexes shows much less difference. The difference, according to Le Bon, between the average capacity of the skulls of male and female Parisians is almost double that found to obtain between the skulls of the male and female inhabitants of Ancient Egypt. Civilization, by giving increased exercise, especially to the male brain, has, there is good reason to believe, gradually produced that increase of brain capacity which now distinguishes the civilized from the savage races of mankind. Nowhere has this influence been more conspicuous than in China, whose culture, if not of the most advanced kind, has the advantage over all others in the great length of time it has endured. The Chinese are, as might have been expected, a big-brained people; indeed, the only statistics of Chinese brain-weights available show them to exceed all other nations in this respect. A few years ago the brain-weights of 11 adult male and of 5 female Chinese—the chance victims of a great typhoon at Hong-Kong—were obtained. These belong, with one exception, to the coolie or lowest grade of Chinese society, yet the average brain-weight of the males reached $50\frac{1}{2}$ oz., and that of the females $45\frac{1}{2}$ oz. This is an average not attained, so far as yet known, by any other nation, it being fully 6 oz. above that of the average negro, $1\frac{1}{2}$ oz. above the European,

and $\frac{1}{2}$ oz. above the average Scotsman. That civilisation has been the main cause of increase in the size of the brain there can be little doubt. To admit, therefore, that the heads of the British people are now growing smaller, would be to confess that the resources of civilisation were indeed exhausted, and that, as a people, we had begun a retrograde journey towards the barbarism from which we originally emerged.

THE SKIN, AND ITS MANAGEMENT IN HEALTH.

BY DR W. ALLAN JAMIESON.

IN order to protect the delicate structures of which the body of man and the higher animals consist from rude contact with the external world, it has been sheathed in a tough yet sensitive and elastic covering, which is known as the skin, and I propose this evening to tell you something of its construction, as well as to point out what are the various functions or offices which are performed by it, as one and an important part of the living body, and also how to treat it so as to maintain it continuously in a condition of healthy activity, as well as to prevent its becoming as far as possible the prey of disease.

Simple though the skin appears to be, it is a complicated organ, but we may speak of it under three divisions. *1st.* The skin proper; *2d.* The glands contained within it which supply oil and perspiration; and *3d.* The appendages which it bears—the hairs and nails.

The outer surface of the skin is comparatively dense and hard, so as to resist the more or less destructive influences of weather and occupation. It is known as the cuticle or scarf-skin, and is constructed of an infinite number of thin horny plates or scales, laid one on the top of another, and firmly attached except on the very surface, where they become gradually loosened and are constantly being cast off. This shedding of the outer layer of the skin is nearly imperceptible in health. It is this which makes up most of the cloud of dust, which flies off when a stocking is shaken, after having been worn a few days. This bran-like powder consists mainly of horny plates which have done their

duty, have become dry, old and useless, thus loosen, and fall off. The thickness of the horny layer varies in different parts; it is thickest on the soles of the feet and palms of the hands, thinnest on the eyelids.

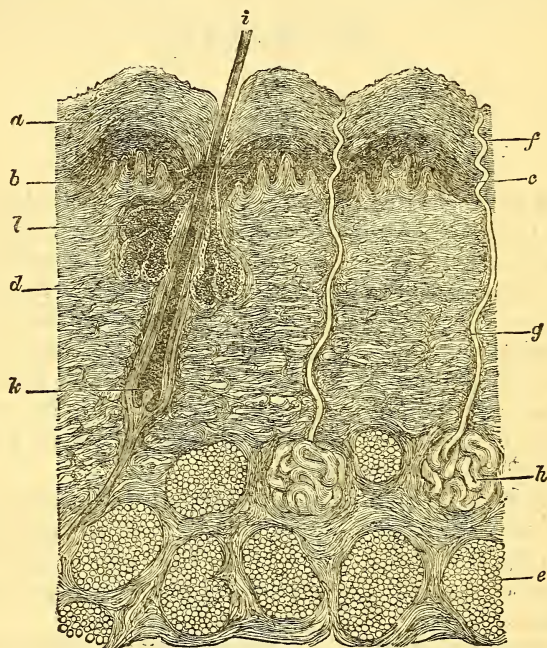


Fig. 1.

Section perpendicularly through the healthy skin. *a.* Epidermis or cuticle, *b.* mucous layer with pigment, *c.* finger-like projections of true skin, *d.* true skin. *e.* fatty masses, *f.g.h.* Sweet gland and tube or duct. *i.k* Hair, with its follicle and papilla. *l.* Sebaceous gland attached to hair follicle.

Underneath this layer the skin is more succulent and soft, and is made up of numbers of bodies called cells, each actively growing, united to one another by a transparent cement substance, and further joined in the deeper layers by fine spines or prickles, which project from their surface and interlace. This layer is called the mucous layer, and just as the mucous membranes of

the inner surfaces of the body secrete or form a peculiar watery fluid called mucus, which keeps them moist and ready for the duties they have to carry out, so the mucous layer of the skin secretes the outer horny covering which lies above it and protects it. It used to be thought that these actively growing cells became themselves changed into the horny outer plates, by a gradual process of change. The most recent researches shew that such is not the case, but that the outer cells are distinct from those deeper, and secreted or produced by them, not merely themselves become thin, dry, and hard.

The colour of the skin, brown, black, olive, or white, is due to the shade of the deepest cells of the mucous layer. These, only slightly tinted in the white races, are much more intensely so in the dark. Both heat and light tend to increase the proportion of colouring matter in the skin, hence the bronzed face of the soldier who has been exposed to the Indian sun, and the brown patches on the front of the legs of furnacemen and others, who stand for hours before glowing fires, though protected from its light by their clothes.

Still passing deeper we come to the true skin, that part which in animals, when tanned, gives body to leather, which contains those fine tubes, whose office it is to convey to it its supply of nutritive fluid—the blood. Suited to its requirements, this part of the skin is made up of a mesh work of fine fibres, which interlace so as to compose a structure like felt, tough yet elastic. Within this the bloodvessels branch and divide with ease, and are sustained and separated. It is delicate and close on its external part where it underlies the mucous layer; looser and more open deeper down where the sweat glands and roots of the hairs are embedded in it. The openness of texture of the deep portion gives the secreting part of the glands room, permits the skin as a whole to move, and it is in this part that water accumulates in dropsy. The surface of this true skin is not smooth; it rises into points or prominences which, like so many fingers, push themselves into the mucous layer, and thus bring the ends of the nerves nearer the exterior of the skin, so that we can feel with greater exactness, and also a larger surface is obtained than if

the top was flat. Still deeper, the mesh work is very open, and here contains fat, which in life is fluid, and fills minute bladders. The office of this fat is partly to give roundness and plumpness, partly to pad and protect, and partly from its great non-conducting power to keep in heat.

The skin is richly supplied with blood, and the vessels which contain this form three important net-works. One of these surrounds the glands of the skin, and ministers to their nutrition. Another runs somewhat horizontally at the deeper part of the true skin. A third, also horizontally, at the bases of the finger-like projections on its summit. Into these it sends loops. As in all other parts, the blood is conveyed to the skin by arteries, and from it by veins, which communicate by fine hair-like tubes. The mucous and horny layers contain no bloodvessels; but fine nerves terminate in and among the cells which compose the former. And when the horny covering is removed, as by scraping against a rough stone, the quick, namely, this tender mucous layer, is exposed and blood immediately oozes out. The delicate capillaries, as the hair-like terminations of the bloodvessels are called, give way under the pressure of the circulating blood within, having no longer the support of the cuticle, while the fine terminations of the nerves being laid bare, manifest their resentment by the sensation of pain.

There are, however, other structures in the skin proper. One of these is an elastic substance, which is distributed through the skin in fine curled threads. These, like a coil of watch spring, when straightened tend to recover their natural shape, and thus restore the skin when stretched as by the bending of a joint to its smooth condition. The elasticity of these fibres is greater in youth, and becomes lessened as age advances, hence the skin, often stretched in one particular direction, does not quite recover itself, and, as a result, wrinkles make their appearance. This is partly the cause of the furrows which care, anxiety, or ill-temper stamp on the face. Another factor of these is the muscular structure in the skin, an element which regulates its functions in a remarkable manner. There are two kinds of muscle distributed through the skin. One of these is scarcely found except

in special regions, as the face, hand, &c., the other nearly everywhere. The first form is distinguished by being marked with fine cross bars or lines, and is under voluntary control. By the contraction of its fibres the skin is thrown into folds, and thus we are able to express the feelings and emotions, slight changes in certain muscles giving an entirely different cast to the features. But far more important as regards the well-being of the body are the non-striped or involuntary fibres of muscle. These are not directly under the influence of the will, but contract and relax in response to alterations of temperature, or to mental states, as fear, which causes their contraction and blanches the face, or shame leading to their relaxation, which permits an over-filling of the vessels of the skin, and the tell tale blush appears. These involuntary muscular fibres are arranged in various ways. Some obliquely, which, when they contract, compress the component parts of the skin together, and make it thinner. Some lengthwise at the base of the little prominences on the true skin; these check the outflow of perspiration. Some to the hair glands; these, when they shorten, make the hairs stand up, and squeeze out the oil from the oil glands, thus preventing it from drying up, and so choking the apertures. When the surface of the body is exposed to cold, these little muscles contract in all directions, force the blood from the surface, lessen the production of sweat, and thus maintain the natural heat of the body by diminishing evaporation from its surface. On the contrary, when we are exposed to heat, either from the sun's rays, or, what is practically the same thing, when we exert ourselves and thus become warm, these muscles relax, allow more blood to flow to the surface, the sweat glands act with more energy, the surface becomes moist, but with a salt fluid which evaporates slowly. And this in drying cools down the exterior, and maintains the uniform temperature of health. It is necessary here to tell you what that temperature is. Whenever the heat of the body rises above 98·5 degrees Fahrenheit, the condition is that of fever. The external temperature of the body, say in the armpit, may be a little below this without any departure from health. If it exceeds it at all, at least for any length of time, there is some-

thing wrong. By the action of these little muscles, then, the body is maintained at or below the temperature of 98.5° . In saying this, however, I do not mean to exclude the bloodvessels themselves from bearing their part. The tubes of which they consist are both elastic and contractile, and they, as well as the muscles of the skin, are under the control of the nerves, which, partly influenced by the will, but more particularly automatically, induce their dilatation and contraction as the necessities of the body require. They thus regulate exactly the amount and proportion of nutriment conveyed in the blood to each portion of the skin, and maintain it in vigour.

There are implanted in the skin at various depths three species of glands. One of these provides perspiration or sweat, another an oily material, and the third hair. This latter is also looked on as an appendage of the skin, but, as will be seen, it may be regarded as much a secretion as the sweat is.

The sweat glands consist partly of a coiled-up tube lined with secreting cells, and planted deep down among the fatty substratum ; partly of a long duct, also lined with cells, leading upwards from the coil ; partly of a tunnel without any proper walls, which runs spirally through the upper layers of the skin. The openings of the sweat glands, which are set with considerable regularity, can be seen with a strong magnifying glass as little pits or depressions on the points of the fingers, between the ridges which occur there. These are what are popularly known as the pores of the body. Their total number varies in different persons, but has been estimated at in round numbers 2,300,000. From this estimate some conception of their importance may be derived.

The sweat, which is a compound fluid made up largely of water containing common salt in solution, also some fatty material, is continually being poured out. Though the openings on the surface are free no sweat can, when the body is at rest or not too warm, be seen to ooze from them. This is in consequence of the spiral arrangement of the outer part of the duct, by means of which the perspiration soaks the outer horny layer and keeps it pliant and moist, being thus imperceptibly exhaled from the surface, constituting what is known as the "insensible perspira-

tion." The total amount of watery fluid which thus escapes by the skin has been calculated at two pounds or pints daily. This is largely increased by exercise, warm weather or rooms, etc., and bears a direct relation to the quantity given off by the kidneys

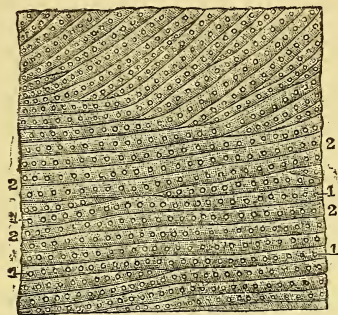


Fig 2.

Openings of the sweat glands on the palm of the hand. Magnified four times. 1. Openings of glands. 2. Furrows or ridges between the lines of openings.

and lungs. How important, therefore, it is that the perspiration when being freely poured out should not be too suddenly checked. When this happens the lungs or kidneys are called on to do increased work without due warning, and they and other internal organs, as the liver, stomach, and bowels, are liable to become all at once too full of blood and inflamed. When one is tired after exertion, and thus in a depressed and weakened state, and freely perspiring, should this evaporation from the surface be rapidly checked and dried by sitting in a current of air—a draught as it is called—some internal organ becomes congested and we “catch a cold.” Hence arise jaundice, acute indigestion, diarrhoea, as well as inflammation of the lungs or kidneys. This may sometimes be warded off by again quickly restoring the action of the skin by a hot bath, combined it may be with a tumbler of toddy. In most cases the mischief has been done ere this is resorted to.

It is thus seen how completely in harmony all the functions of the body work together in a condition of health. In cold weather

the skin is least active, more water is given off by the lungs and kidneys, consequently there is more danger should inflammation then attack them. Again, in summer the skin pours forth its watery excretion more abundantly ; this, in evaporating, cools down the surface and maintains the uniform temperature of health, while the kidneys often secrete more scantily. Every one must have remarked that when a sudden change of weather from hot to cold occurs the kidneys act at once very freely. This is simply due to a rapid diminution, in consequence of the lowered temperature, of the insensible perspiration. The sweat is usually acid. Sometimes it becomes intensely so, as in rheumatic fever ; on the other hand, when profuse it may be alkaline or neutral, and then it putrifies readily, giving rise to odours which are extremely unpleasant, both to the person and to those around him.

The second variety of secreting glands found in the skin are the oil glands. A modification of these are the glands which form the wax found in the ear passage. These oil glands, or sebaceous glands as they are called, are commonly placed in close association with hairs. Most of them indeed open into the sac, or follicle which produces the hair, and the fatty material which they provide is conveyed gradually to the surface by the hair in its process of growth. It thus oils the hair as well as the skin. Each gland consists of a number of pouches containing cells, which elaborate the oily material, and finally burst and set it free. Sometimes this oily matter is produced in too fluid a state, and when so, can be seen to ooze in minute drops from the oil glands of the nose and cheeks. Dust and smoke adhere easily to this, and the face constantly looks grimy and unwashed. There are no oil glands on the palms or fingers, but the sweat secreted there is greasy ; and this explains why, when a hand moist with perspiration is placed on paper it leaves a stain. In some of the lower animals, the aquatic birds in particular, these oil glands are much more highly developed. In them they oil the feathers which otherwise would become wet and heavy ; and hence the saying that "our words made no more impression than water on a duck's back." Sebum, as this oily matter is termed, tends when allowed

to accumulate, and in consequence of the heat of the body, to become rancid, and smell strongly. This is more apt to occur in the dark than the white races of mankind. It would appear that every one has an odour peculiar to himself, and it is this which enables the dog to recognise his master, the bloodhound to track the outlaw. When the hands are brought in contact with animal or vegetable matter in a state of decomposition, the smell of the substance touched attaches itself to them, and in all likelihood especially to the fatty secretion. Soap does not remove the odour. Carbolic acid or Condyl's fluid disguises it for a time, to reappear nearly as pungently as ever. If, however, as Dr Foulis has suggested, we smear the hands well with turpentine which dissolves the oily secretion, and then wash them with soap, the unpleasant smell will be found to be permanently and harmlessly removed. This is not a mere matter of sentiment. Some poisonous materials can thus be conveyed from one person to another. By employing turpentine these are rendered innocent, and the danger of contagion lessened materially if not altogether abolished.

The third series of skin glands are those which produce the hair, and these exist nearly universally. On the palms and soles and one or two other situations they are absent. These glands are seated at various depths; those which form the fine down which covers the arms, back, &c., are near the surface, those whence the hair of the head and beard grow are planted deep among the fat cells under the skin. The hair glands are only foldings in or pouches of the skin; and the hair is nothing more than the horny covering of the skin, which has grown into a thread-like form. The pouch which produces the hair is wider below than above, and has a nipple-like projection at its deepest part, into which bloodvessels and nerves run. This is the active agent in forming the hair. The root of the hair has a dimple, much like the hollow in a champagne bottle, corresponding to the hair papilla, and is soft. As it grows upwards it becomes firmer, and when it emerges from the skin the hair consists of a bundle of fibres, variously coloured in different individuals, bound together by flat plates, the lower of which always slightly overlaps the next above. This overlapping serves several pur-

poses. One of these is that, as the hair grows, the projecting edges of these plates, scraping the sides of the tube surrounding the hair, carry before them any particles which have become detached from the inside of the pouch, and also the oil secreted by the oil gland which opens into it. Thus the hair literally sweeps out its own follicle. When the hair has become free on the surface, this arrangement permits us to brush dust, &c., from its root to its point, and also favours the conveyance of perspiration or water from the body. Hairs are set at an angle to the surface, not perpendicular, and in what are called whorls or spirals. This spiral arrangement of the hair is well seen on the crown of most boys' heads. Hairs are not in general quite round, but somewhat oval, and the greater the oval the more the hair tends to curl. Hair, too, is nearly indestructible by time alone. A coil of hair, with the pins of jet still sticking in it, once the ornament of a young Roman lady, was found the other day quite fresh in a stone coffin near York, carrying us back to the dawn of the Christian era.

During life, however, each hair has a definite period of life. This is much longer in some persons than in others, and bears some relation to the state of health. A calm, easy life, a placid disposition, and a well-nourished body, offer a combination of circumstances most favourable to the production of long hair. Such was in all likelihood the condition of that worthy burgo-master of Brock, a sleepy town in Holland, of whom it is recorded that he had so voluminous a beard that he kept it tied up in a bag. One day having permitted it to hang down unrestrained, he tripped over it on the stair of the Court-house, fell and broke his neck. The nutrition of the hair is often a good index of the state of health. Thus when it is glossy and pliant, does not fall off much, is weak or split easily, the possessor may, as a rule, be considered as in good health. In most persons, as age advances, it becomes white. This is rarely if ever unbecoming. It is said that a lady once remarked to Douglas Jerrold that she could not understand why her hair was turning grey, unless it was occasioned by the essence of rosemary which her maid was in the habit of using to wash her head with. "I fear," said the

witty dramatist, "it is much more likely to be due to the essence of time." Some, however, apparently forgetful that there is something incongruous between a wrinkled cheek and dark hair, try to improve on nature by using artificial dyes. Though most of these contain lead, probably any harm they can do is exaggerated, yet they are rarely successful because too much is attempted, and the fraud becomes patent to all. Each season in the year of life has its peculiar and suitable tints, which blend to form a consistent and beautiful whole.

The nails are plates of horny material which correspond to the outer layer of the cuticle. They, like the hairs, grow from a root, the imbedded part of the nail farthest from the point of the finger. They are, however, firmly attached to the bed or quick, over which in growing they slide, receiving little, if any, increase of thickness from it. The object of the nails seems to be to make the point of the finger firmer than it would be did it end round and pulpy. Nails grow more quickly in the young than the old, in summer than in winter; and the rate of growth of the nails on corresponding fingers of each hand is not quite uniform. It averages $\frac{1}{30}$ of an inch a week on the hand, less on the feet. During severe illness, such as rheumatic fever, the growth of the nail at its root is arrested, and when recovery has taken place and the nail increases again, a groove appears by-and-by on its surface, which in depth and breadth bears relation to the length of time the illness has lasted. This may serve to show what a shock such illnesses give to the system generally.

Dried up and decayed cuticle often accumulates by the side of the great toe nail, more particularly on the side next the other toes. This being picked out with the scissors, when the nails are cut, the pressure of the boot, too frequently made very narrow at the toe, forces the edge of the nail against the tender part from which the accumulation has been removed. The pressure leads to the formation of a sore; proud flesh sprouts out, and the nail is said to have "grown in," necessitating sometimes a painful operation for its cure. All this might be avoided were boots or shoes with broad square toes worn, the toe nails simply cut straight across, and the sides cleaned by means of a nail brush,

soap, and warm water, and never picked. When dirt gathers under the free edge of the finger nails it should not be scooped out with a pen-knife, but washed away with soap and water and a brush. Picking the nail raises it unnaturally from its bed, and more dirt collects. It should be remembered, too, that children's feet grow fast, at an early age especially, and shoes soon become too short—the great toe, prevented from becoming longer, bends towards the second toe, the foot is weakened, and in time bunions form on the ball of the great toe. It is rare to find an absolutely natural great toe, just because at some time too short shoes have been worn when the foot was growing.

Having placed before you this sketch of the structures which compose the skin and its appendages, its management in health must now engage our attention. Cleanliness is in great measure the outcome of a state of civilization. Among savages when in their wild condition washing is almost unknown. The human being in a state of nature uses water simply to cool his body in summer, never to cleanse it. In winter he wears unchanged the skins or mats which form his defence from the cold. The higher the state of civilization the more the luxury of bathing is indulged in. Yet there are many thousands in this country who never wash from year's end to year's end. Two Glasgow lads were disporting themselves in the Gareloch one warm day during the fair holidays. One remarked to the other how black his skin was. "And so would yours be," was the reply, "if you had not touched water since this time last year." History repeats itself, and just as bathing was an art among the ancient Greeks and Romans, so the multiplication of water cure or hydropathic establishments among ourselves must be looked on as an evidence of the estimation in which baths are held by the middle classes now.

No sooner have we opened our eyes and uttered our first shrill cry as helpless infants, than our nurse sets to with a will and soaps and scrubs us till our skin glows rosy pink. For six months, perhaps longer, be our home the poorest, we have a daily bath at least. As we begin to move about, and come more directly in contact with dirt, by a strange inconsistency we are

less often washed ; and by the end of our second year we may, if mother is also nurse, and a successor to the honours of the bath has appeared, be put off with a weekly Saturday night's tubbing. When a little older the boy or girl in many a poor home is well off if he even gets that. I know there are many difficulties in the way, when rooms are small and furniture scanty. But a great deal might be done by hanging a sheet across a corner of the room, behind which a thorough wash might with due regard to propriety be obtained.

What happens when the skin is not regularly washed and kept clean ? The dust which is always around us, the particles thrown off by our clothes in course of wear, and the secretions which are perpetually being poured out by the glands of the skin themselves, all accumulating, plug up the innumerable openings, and prevent their working. Hence an indispensable agent in getting rid of much worn out material from the system acts but very imperfectly, and more work is thrown on internal organs to take its place. Health suffers, and though the body with wonderful adaptability to circumstances submits to much, still discomfort, to say the least, to the individual arises, and annoyance to the more cleanly members of society. Singular to say, our paupers dislike extremely the bath which is the necessary introduction to the workhouse, and many members of the lawless classes detest the prison regulations as to washing. Hence that cleanliness so scrupulously observed by many of the lower animals seems to be an acquired habit in man.

The skin from being oily cannot be cleaned by water alone. And though the morning cold bath is bracing and invigorating, and aided and supplemented by friction with a rough towel, removes much of this secretion, some substance which will so alter the greasy coating as to render it capable of being washed off must be employed in addition. This is found in soap. Now soap consists of a combination of an alkali, such as soda or potash, and oil or fat. These when mixed and boiled in certain proportions form a definite compound, either hard when soda, or soft when potash is the alkali. There is always in soap some free or uncombined alkali, and this, when the soap is rubbed with

water on the body, unites with and renders soluble the oily material of the skin. Potash soaps contain too much and too strong an alkali, hence when the skin is washed with soft or black soap, the natural oil is so thoroughly removed, that the skin is left dry and harsh, and feels to its owner as if too tight for him. The injurious effects of the constant use of these strong soaps are seen on the hands of washer-women, in whom they produce a disease which cannot be cured unless the employment is abandoned. In a well-made soap, however, a soda or hard soap, compounded from pure fat, thoroughly boiled, and then matured by keeping—all good housekeepers know the economy there is in having soap for some time in the house before it is used—the amount of free alkali is small. This cleanses the skin, but not entirely removing the oil, leaves it soft and pliant. All soap should be entirely washed off with water before the skin is dried. Unless this is done the face looks shiny and smooth, more suggestive of an attempted than a completed washing. “Use doth beget a habit in a man,” thus the more regularly and constantly soap is employed the more it becomes a necessity of life. Those who wash daily with soap miss it more when from illness or any other cause they are deprived of it, than those to whom its use is merely occasional.

A word must be said about various kinds of soaps. Old Castile soap or Pears’ soap are excellent, but expensive. Very pure soap can scarcely be cheap. The fatty ingredients must be selected and pure; and the soap like good wine should not be too new before it is sold. All this costs money, and must be paid for. Pears’ soap and transparent soap generally is further purified by being dissolved in spirit, which removes any accidental impurities. White soap made by respectable firms is usually pure enough for all ordinary purposes. Highly coloured and scented soaps, too often reserved specially for baby’s use, are in general to be avoided, and so are medicated soaps. Sulphur soaps, for instance, are irritating, and so are carbolic acid soaps. The latter is sometimes useful as a disinfectant, but when kept, the carbolic acid evaporates, and with it any particular virtue. Coal tar soap is of a little value in some diseases of the skin, in

most it does harm. One soap I can recommend, as it is made at present—Sanitas toilet soap. Sanitas is turpentine, through which a stream of hot air has been passed for a long time. The turpentine becomes chemically altered in the process, and this, when combined with a well-made soap, imparts to it an agreeable odour, and makes it more cleansing, though not too drying for the skin. A little of this soap goes a long way. The hair when washed with it feels free and clean on being combed. Sanitas fluid itself, diluted with four times as much water, makes a good wash for the hair. Honey soap is said to be a good soap. Glycerine soap is not, for the glycerine does not unite with the soap, and exudes as drops on its surface.

There are popular prejudices against washing certain parts of the body. One of these is that the face should not be washed with soap, as thereby the complexion would be injured. Now the reverse is really the fact. Dust and soot adhere to the oily material poured out by the glands of the face, and stop up their openings. Unless soap is used to keep them free and active, these glands become sluggish, and thus give rise to a "bad complexion." No doubt in many cases there are other causes at work, as indigestion, tight-lacing, living in close ill-lighted rooms—sunlight being as necessary to produce bright and fresh colour in human beings as it is in plants. Unhealthy occupations are also causes, and occupations which not in themselves unhealthy are made so unnecessarily. Thus many shop-girls are seriously injured, because their employers insist on their standing behind a counter for many hours without sitting down, even when not employed in attending on customers. I mention this particularly since attention has lately been drawn to this species of cruelty by the medical papers. The plan is a short-sighted one, for tired girls cannot so well or so cheerfully work as those refreshed by resting from time to time, when not actively engaged in selling. This is a real cause of not a few of the pale and spotted faces we see among shop-girls.

Again, colliers, perhaps other operatives, believe that washing the back weakens it, and thus leave it untouched. There is a

trace of human inconsistency here, since their wives bathe their children's weak legs to strengthen them.

The feet though in constant use do not receive their due share of washing, though they need it as much or more than other parts which always in view are necessarily cleansed frequently.

Mothers and nurses refrain, possibly through a mistaken fear of giving cold, from washing that part of infants' heads on the top in front where the bone is defective at birth, popularly known as the "open of the head." Hence a greasy substance gathers, forms a thin crust, this turns rancid, and becomes often a starting point of those outstriking on the face and head of infants which are ascribed to teething. This part of the child should be washed as often and as carefully as any other, dried scrupulously, and, if necessary, anointed with a little vaseline or cold cream to prevent scurf from collecting.

If at all possible, the whole body should be washed once a day. The best time is on rising in the morning, as then the plunge into water, which should be, at all seasons, about the temperature of 60°, is invigorating and refreshing after awakening from sleep. A very few minutes suffices, and the hardening effect on the body, rendering it less liable to be afterwards chilled during exposure to this variable climate of ours, is worth all the time snatched from sleep. A substitute for the plunge into water may be extemporized by dipping a towel in cold water, and thoroughly scrubbing the body with it. Such a bath causes the muscles of the skin to contract, lessens the amount of perspiration for a time, and acts as a tonic.

A bath should not be taken immediately or even soon after a meal. An hour and a-half at least should be allowed to elapse. This applies to all forms of baths. A cold one first drives the blood from the surface and blanches the skin, followed, if the exposure be not too prolonged, by an agreeable sensation of warmth, and a feeling of lightness and increased vigour. This is due to the bloodvessels again dilating and the warm current flowing through them with augmented activity. It is this pleasant afterglow which is the test of the beneficial effect of a bath or otherwise.

Unless it is experienced in some degree a cold bath should not be indulged in.

When the blanching of the skin, due to the sudden contact of cold water with its surface, takes place, the blood displaced from the skin congests internal organs, and this occurring when digestion is actively going on interferes with its progress, and disturbs its regular course. This also explains why persons sometimes feel sick after a bath, and why we pant when we step first into the sea, at least when the water reaches the level of the chest, the lungs being for a time overfilled with blood. A warm bath on the contrary raises the temperature of the skin above its natural standard, and withdraws blood rapidly from internal organs, as the stomach or brain. Faintness may thus be induced in those who have naturally little blood, or are otherwise not very strong. The brain in them, not at any time over well supplied with blood, becomes still less so, and faintness or actual fainting occurs. When we come out of the warm water and the skin is dried, the cooler air around us increases evaporation from the skin, and also drives the artificial excess of blood away from it, and we feel cold. Thus the warm bath has its uses, and there are times also when it cannot be employed without harm. It may be used beneficially to cool a fevered skin, and so it is constantly made use of in many children's diseases. Or, again, to restore the proper action of the skin, when this has been checked by exposure to cold or damp. When this has been done, however, the artificially induced warmth must be maintained by going to bed. Thus a warm bath pure and simple, and by this I mean one whose temperature is above 95°, should only be taken when this is possible immediately after. As thermometers are not always at hand, a ready way of estimating the heat of the bath is to plunge the naked elbow into the water, and thus we can very accurately determine it. There will thus be no risk of scalding children, as has been done, when the hand which often stands a high temperature is used as the test. A warm bath interferes with digestion by withdrawing blood from the stomach, and thus checking the process.

We can by certain medicines stimulate the sweat glands to increased activity, but as a means of perfectly and thoroughly

cleansing the skin the Turkish bath stands unequalled. In it we have, first, profuse perspiration, due to continued exposure to a high temperature, then thorough cleansing by means of soap, and, finally, a gradual cooling down by a spray bath, whose heat is constantly diminished to nearly icy coldness. It must be borne in mind, however, that the Turkish bath does not agree with every one, nor is it to be employed except occasionally, for though producing at the time a sense of increased strength and buoyancy, its too frequent repetition is not without risk, and to it has been ascribed with some reason the origin of one form at least of skin disease. A remarkable instance of the effect of the Turkish bath on the skin was given by an Irishman, who, writing home to his friends, after describing how the bathman, during the shampooing process, scraped off layer after layer of accumulated dirt, declared that he finally triumphantly unearthed an old flannel under vest, of whose existence the said Irishman had had no recollection.

It may be well to say a word here as to bathing in fresh and salt water, and their influence on the skin. Sea bathing is admitted by all to be much more invigorating than fresh water. Much of this is due to the pure sea air, and to the rest from care and business which accompanies a residence at the seaside. But there must be a something in the water itself, and this has usually been explained as dependant on its higher specific gravity. Further than this we cannot at present safely go; certain it is that a sea bath is more strengthening, and if from the presence of salt less cleansing, can be indulged in by those who would derive little advantage from a river or lake bath, though in the absence of sea water these are not to be despised.

Is it safe to bathe when warm and freely perspiring? Yes, if from previous experience we are conscious of that pleasant glow on emerging from the water of which I have already spoken, and provided we are still vigorous and healthy. While the blood flows rapidly through the vessels, and the skin is turgid, a plunge into moderately cold water taken at once, and followed by friction in drying and then hasty dressing, is safe and advantageous. Should, however, the perspiration have ceased and dried, and the skin again become relaxed, a cold bath cannot be indulged in

without risk. There is no subsequent glow and reaction, nausea is apt to supervene, and ill effects to the system generally to follow. Even a tepid or warm bath should then be taken with care.

Hard water is injurious to the skin. It makes it rough, and tend to chap, all the more if easterly winds are prevalent. Hardness in water chiefly depends on the presence of a compound of lime, commonly the carbonate. This, when brought in contact with soap, decomposes it. The lime unites with the oily acid, and forms with it a soap of lime, which is insoluble. The potash or soda thus set free unites too perfectly with the natural oil of the skin, and thus dries it. Boiling renders hard water somewhat less so. The carbonate of lime is held in solution in the water by free or uncombined carbonic acid. Boiling drives this off, and so much of the lime is deposited. This composes most of the crust which forms in our kettles and boilers. When only hard water is available, we can thus make it softer and less injurious to the skin. Rain or river water is preferable, if these can be had.

When persons grow old they not unfrequently become less careful about washing themselves. No doubt with failing health less regard for personal appearance, and possibly a degree of laziness, there is an explanation, but not always an excuse for this. But as the skin becomes more shrunken its glands are less active, and dirt and its own excretions accumulate in the wrinkles and furrows, consequently washing should be more carefully done, but with warm water.

The care of the skin, however, does not merely consist in washing it. Its due covering and protection are as necessary, perhaps even more so. There is quite an agreement among medical men that in our cold, damp, and too often sunless climate, nothing surpasses flannel or some woollen material as the article of clothing to be worn next the skin. Wool is a bad conductor of heat, and thus keeps in and maintains the warmth of the body. It absorbs the perspiration and oil, and takes up the dry scales which are being constantly thrown off. Thus it should be changed pretty often. Just about a hundred years ago Hugo Arnot gave

as an instance of remarkable personal cleanliness, that the late Archbishop of Glasgow put on a clean shirt once a week ! Though this would not excite wonder at the present day, the fear of changing body linen still lingers in the case of sick persons and children, whose comfort is interfered with and whose illnesses are sometimes prolonged through a false dread of their catching cold were this done. Provided that those to be put on are warm and dry, there are few instances indeed where a frequent change is not in every respect beneficial, care being taken that in the process the sick person is not unduly fatigued. In the case of children warm under flannels are very necessary, as they bear cold badly, and the younger the child the less resistant it is to it. Fashion still rules the day as regards the outer garments, but those next the skin should be warm and close-fitting. The same underclothes should never be worn at night as well as in the day ; and, except in children, where flannel suits best, cotton or linen should be the material of the night-dress.

A whole lecture might be devoted to the hair, and yet its management in health need not detain us long. When short the hair may be washed, if desired, every day, and this practice, if commenced in early life, and continued, is said to postpone at least its becoming grey. It should be washed as often as necessary to keep it clean and its roots healthy. Any good soap may be used to wash it with, or the white of an egg well whipped up, which cleanses it without drying it so much as soap does. It is often recommended to wash the hair with borax. This cleans it, but leaves it dry, therefore very little should be used ; and after the hair has dried some simple oil or pomade ought to be applied, to take the place of the natural oil which has been dissolved away. An oft quoted dictum of some one notwithstanding that "one cannot brush the head too much or the hair too little," brushing should be gentle, and a brush with bristles which are neither too stiff nor too closely set should be chosen. A hard brush breaks and bruises the hair, although it seems to be doing good by scraping off a cloud of scurf. One is apt to forget that the scurf re-forms faster than ever when thus roughly

scratched away. Use, then, a soft brush, and use it gently. And wash the head once a week or fortnight, if not habitually daily. The teeth of the comb should not have sharp points, as these tear the skin of the head. *A small tooth comb should never be used.* It does more harm than a hard brush when employed to get rid of dandriff or scurf, and for any other purpose there are better and more certain methods. A little pomade does no harm, provided it is simple. Perhaps the best is made of equal parts of pure cold cream and vaseline, or cocoa-not oil and vaseline.

At present the natural style of dressing the hair of females may be said to be in vogue. Long may it continue so. And may we never see the return of pads or chignons or other artificial appendages or supports. No part of the body, ladies' waists and perhaps feet excepted, has been so much tortured by fashion, and baldness becomes every day more frequent in both sexes. In women dragging the hair over huge chignons, which themselves over-heated the head, caused it to fall off; and in men the style of head-covering usually worn is blameable for much. Blue coat boys, and the waifs and strays of our lanes, who mostly go bare-headed, have thick heads of hair and retain it long. The same may be said of peasants abroad, who work all day with heads uncovered, or with merely a handkerchief rolled round the head to protect it from the sun. The heads of hair of savage races are quite marvellous for their thickness. Those, on the contrary, who wear hats, especially hard or close-fitting felt or silk hats, lose it soon. No doubt there are other causes—hereditary predisposition, want or thinness of blood, anxiety and worry, still these are secondary. The hat confines the perspiration which rots the hair, and makes it scurfy and dry, while the hard rim of the leather lining band presses the bloodvessels of the temple against the skull, and thus starves the hair by diminishing its supply of nutriment. Hats, then, should first be soft and easy; and second, should be so ventilated that a current of air passes freely over the head. For this purpose it is not enough to have a few holes punched in the crown. The lining band should be made of soft material, widely separated from the hat by a space, and holes made in the sides and front of the hat

itself. This allows free ingress and egress of air, and were this plan adopted and made use of in all head coverings, we would have fewer colds in the head and fewer bald men. The tall or chimney-pot hat worn as dress in this country is too heavy as a rule. In fact it is not a suitable covering for the head in a climate like ours, where rain and particularly high winds prevail. In France and Italy the hats made and worn are much lighter than ours, which are necessarily stronger and heavier to resist the wind. Hence a more rational hat would be a lower and softer one. And when we become wise enough to dress according to the dictates of reason and not fashion, such a hat will be universal; as it is, some clergymen alone adopt it in town.

One reason why women are less often bald than men is undoubtedly because their heads are less closely covered.

Cutting the hair frequently causes it to grow thicker, at least if the hair be moderately short. When the ends of long hair tend to split, the hair should be trimmed at its points, each hair being cut a short way above where it has split, and a little oil applied to the ends. There is no virtue whatever in singeing the hair.

In conclusion, it will be evident that scrupulous cleanliness and suitable protection from cold and variations of temperature are the means requisite to maintain the skin (and with it the body generally, so far as the influence of the skin is concerned) in activity and health.

HOW WE DIGEST OUR FOOD.

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BY JAMES FOULIS, M.D., F.R.C.P.  
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MAN stands at the head of the animal world and has all things in subjection under him, yet he comes from an extremely minute germ or egg, not more than the $\frac{1}{2500}$ th part of an inch in diameter, and weighing scarcely the $\frac{1}{10000}$ th of a grain. An adult man weighs about 130 pounds, so that he weighs a thousand million times more than the germ from which he started.

This little egg or germ, if placed in suitable conditions, has within it the power of absorbing or imbibing nourishment. It has no lungs, no stomach, no heart or any trace of an organ of digestion; and yet it will grow and develope into a perfect human being, if the conditions favourable to such development are present. The first trace of the development consists in the division of the little egg into two halves. It actually divides itself into two halves—then each half divides itself, and then each quarter divides itself, and this division goes on until the whole egg is reduced to an immense number of little bodies called *cells*. Each of these little cells, though much smaller than the original egg, is very like it in structure. The mass of cells thus produced continue to absorb nourishment from the mother's blood, just as the egg did in the first instance. Presently the cells arrange themselves in a peculiar manner, some of them develope into the brain and spinal marrow, others develope into heart and lungs, others into bone, and so on until the perfect little human being is formed. Now, what I have told you of the first steps in the development of man, is exactly the same as takes place in the first steps of the development of every vertebrate animal. In the cat, the

dog, the monkey, the elephant, and all the other animals of this class, a minute egg is the first trace of the animal. Division and subdivision of the egg takes place, and then the minute bodies or cells formed by this process of division gradually give rise to the different organs and the distinguishing characteristics of each animal.

I mention these few facts about the first steps in the development of man, because I wish to direct your attention to the wonderful power possessed by the small bodies which we term "*cells*." I shall have to show you that in the human body there are millions upon millions of minute cells, all undoubtedly derived from the original germ or egg, and that these cells are really the means by which we digest our food. I shall have to show you that although we eat food, we, as individuals, do not digest it. We cannot digest our food, let us try ever so hard. We do not digest our food by any effort of our wills. We cannot convert our food into flesh and blood any more than we can control the beating of our hearts. The digestion of food, or the process of converting it into soluble material so that it may pass into the blood, is entirely carried out by the agency of countless millions of cells lining the alimentary canal, over which we have no direct control whatever. I hope to make this clear to you by-and-by.

Before the child is born, although it possesses a stomach and intestines, a mouth, and other organs of digestion, it does not *eat* food. Such nourishment as it requires is absorbed from the mother's blood. The mother eats the food and digests it, while the child absorbs such nourishment as is necessary for its development. This absorption of nourishment by the child takes place without either the mother or child knowing anything about it!

When the time has arrived for the young child to lead a separate existence, it comes into the world the most helpless of all animals. Before its birth no air entered its lungs; but now on coming into the world it opens its mouth and begins to cry lustily. By this means it breathes the breath of life; but with this breath of life it also breathes in a tendency to death, for if it breathes the oxygen of the air it begins to waste or burn away, and if not fed with milk or other appropriate food it will surely

die. Let it have food, and the minute cells which constitute the essential parts of the organs of digestion will convert this food into flesh and blood, and the young creature will grow faster than it can waste away ; and thus it will pass from childhood to boyhood, and from boyhood to manhood.

When fully grown a man has more than 200 bones in his skeleton. In the skull we see the cavity which contains the brain—the organ of mind. The eyes, the ears, the nose, the mouth, are situated in close relation to the brain. In the vertebral column is a tube which contains the spinal marrow, and attached to the spinal column are the ribs, which enclose the chest cavity, in which are placed the heart and lungs. Then we see the different bones which form the arms and legs and hands. All these parts are clothed with muscles.

There are more than 400 muscles in the human body. The muscles, by contracting, move the limbs. It is by means of the muscles that we can walk about and move our bodies from one place to another. There is a very remarkable muscle called the *diaphragm* or *midriff*, which runs across from the bottom of the ribs to the spine, shutting off the cavity of the chest from the abdominal cavity. In the cavity of the abdomen are placed the organs of digestion, the *stomach*, *liver*, *intestines*, and *pancreas*. In the chest the heart and lungs rest on the upper surface of the muscle called the diaphragm.

The whole body is clothed with the skin or integument. This skin can be easily removed from all parts, but at the margins of the various apertures of the body it seems to stop, and becomes continuous with the mucous membrane which lines all those internal cavities, such as the alimentary canal, into which the apertures open. Every well nourished body has a considerable quantity of fat between the skin and the muscles, and it is this fat which gives such beauty and roundness of form to the human body. Sometimes the fat is of enormous thickness. In very stout people fat under the skin is sometimes several inches in thickness. It is often deposited in a very thick layer under the skin over the abdomen. In this situation I have seen it seven inches thick. In the skin over the surface of the body there are numerous sweat

glands. These glands are minute tubes, and are about two and a half millions in number, and to show you how important they are as organs of perspiration, I may tell you that if these little tubes were placed end to end, they would form one tube 28 miles in length. While you judge of the beauty of the human body when properly nourished, as depicted in the statue of the Three Graces, as a contrast you may look on the horrible effects of starvation. In the famine at Orissa, in India, several years ago, many thousands of our fellow-creatures were starved to death.

What I now show you is a photograph, from life, of some of the poor starved creatures. Only those who have witnessed death from starvation know of its horrors. Let us who have a good supply of food, although from other nations, think twice before we venture to tax the food supply of this country.

Now the body of a living man is always in a state of activity. Even when he is asleep, although the head and limbs are quiet, the heaving chest shows that some parts are active. At all times, day and night, the heart is beating, driving the hot blood to all parts of the body to nourish the various tissues, and to take up the effete and used up material which are conveyed to the lungs, skin, and kidneys, to be thrown off from the body as excretions.

All work means waste. No fire can burn without the coal being consumed, and ashes remain.

Suppose we have a room with walls of ice. As long as the air in the room is *ice* cold, the walls of the chamber will not melt. Let us carefully weigh a healthy living man, and then make him walk up and down in the room for an hour. In doing this he will clearly exert a good deal of mechanical force. At the end of an hour we shall observe that a certain amount of ice has been melted, showing that the man has given off heat in abundance. And if we now examine the air of the room, we shall find that it contains moisture which has been breathed out by the man, and has been given off from his skin by perspiration. If at the end of an hour we again carefully weigh the man we shall find that he has lost weight. Now, from all this, we learn that a living active man constantly exerts mechanical force, gives off heat,

evolves carbonic acid and water from his lungs and skin, and undergoes loss of weight.

Now it is quite clear that this sort of thing could not go on for long without the man wasting away to nothing.

Long before this takes place, however, the man feels hunger and thirst, a craving for food and drink and fresh air with which to build up and to restore the body to its former weight.

For this purpose man takes into his mouth, and then passes into his alimentary canal, every day a certain quantity of food in the form of meat, bread, butter, water, and the like. It is important that you should ever bear in mind that the substances used as food come under four heads :

1st. The nitrogenous food, such as the gluten of wheat, the albumen of white of egg, the fibrine of blood, the syntonin of muscle, the casein of cheese.

2d, Fatty Foods, such as all vegetable and animal oils,—as, butter, bacon, and oils, &c.

3d, Starchy Foods, such as starch and sugar, and nearly all the farinaceous foods, such as arrowroot, corn-flour, potatoes, come under this head.

4th, Mineral matters,—under which head are water and the salts of various metals.

Food, then, in the form of nitrogenous, fatty, starchy, and mineral material, separately or altogether, are introduced into the alimentary canal. *The whole purpose of digestion is to reduce these foods into a condition either of solution or extremely fine division, in order that they may readily pass into the blood through the thin membranes which form the walls of the capillary blood-vessels in the mucous membrane of the alimentary canal.*

THE TEETH.

In the mouth the food is subjected to two different operations, viz., Mastication and Insalivation. By mastication, or chewing, the food is cut up and ground down by the teeth to a state of minute division. This is entirely a mechanical process. It is necessary, in order that the food may be properly acted on by

the different digestive fluids. The teeth are very important organs of digestion. There are marked differences in the teeth, both as to structure and action, corresponding to the habits of the animal and the food it eats.

In fishes and serpents the teeth are generally in the form of spines curved backwards; they serve to catch and hold their prey, and to prevent its escape. In such animals the food is swallowed whole or in large masses, and the digestion is very slow.

In animals which eat flesh, such as the lion, tiger, cat, and dog, there are three different kinds of teeth. The cutting teeth, or incisors, are six in each jaw; these cut the food like a pair of scissors. Next to these are long teeth, in the form of tusks; they are pointed and conical. They enable the animal to get a good hold of its prey, and they pierce the flesh through and through. Then come the molars, or grinders, eight or more in number on each side; they are large and broad teeth, with sharp edges, which have several points or cusps, like the teeth of a saw. In flesh-eating animals the chewing process is very imperfect. The flesh is not ground down, but is only pierced through and through, and mangled before it passes into the stomach.

In animals which live on vegetable food, such as grass, the cutting teeth, or incisors, are only in the lower jaw in those animals which "chew the cud;" but in the horse they are found in both upper and lower jaws. In these animals the incisors simply nip off the blades of grass. The chewing is performed by the grinders. The grinders are large and flat, and their surfaces have projecting ridges of hard material, called *enamel*. By the lateral rubbing motion of these rough surfaces together the food is reduced to a soft pulpy mass.

In the human being the teeth present the characters of the teeth of the flesh-eating and of the vegetable-eating animal.

The incisors are four in number in each jaw. The canines are much less prominent and pointed than in flesh-eating animals. The molars, or grinders, are thick and strong, and have on their surfaces little points or cusps, like we see in the teeth of flesh-eating animals. There can be little doubt, from the structure of the teeth alone, that man is both a flesh and a vegetable eating

animal. Man chews his vegetable food just as perfectly as do the grass-eating animals, and he chews his meat much more perfectly than do the flesh-eating animals.

The teeth perform a most important part of the digestive process. If the food is not properly chewed or masticated, and is swallowed in masses or undivided lumps, it will remain in the stomach a long time undissolved and prove to be a source of irritation to the delicate mucous membrane of the stomach, but if it is properly chewed, and reduced to a state of pulp before it is swallowed, it is then readily attacked by the gastric juice and other fluids, and is rapidly dissolved; hence the great importance of thoroughly chewing food before it is swallowed.

In the human being, each little tooth consists of a crown, a neck, and fangs. The crown is that part which projects above the gums, and is covered with a layer of enamel—the hardest substance in the body. Beneath the enamel is the dentine, a substance like ivory. In the centre of the dentine is a cavity termed the *pulp cavity*, which contains the tooth pulp, a very sensitive body, consisting of bloodvessels and nerves which enter the tooth through a small opening at the end of the fang. Where the teeth rub against each other the enamel and the dentine wear away; but the dentine being much softer than the enamel, wears away more quickly. In the front teeth of animals such as the beaver, the rat, the hare, and the rabbit, the edges are very sharp. The sharp edge consists of enamel, which has not worn away so quickly as the dentine.

In the human being teeth are objects of great beauty when free from decay and properly arranged. Decayed teeth injuriously affect the health in two ways. When broken down they do not grind the food properly, and when decayed they make the breath offensive, because there is always an offensive odour around a decayed tooth. If the teeth are not cleaned day and night, little particles of food get in between the teeth, near the gums, and irritate the latter, which become inflamed, and a white cheesey looking material is apt to accumulate on the edge of the gums. If a very small speck of this white cheesey material is mixed up with some spittle and examined under high powers of the

microscope, it is found to consist chiefly of a sort of fungus, and in among the branches of the fungus are myriads of minute, rapidly moving animalcules called *vibrios* and *bacteria*. It is an extraordinary sight, and once a person has seen it I think he will not neglect to clean his teeth day and night. The teeth may be well cleaned by brushing them with soap and water morning and night. After cleaning the teeth in this way, the mouth may be made sweet by washing it out with a teaspoonful of Condyl's fluid, dissolved in a tumbler of warm water.

THE SALIVA.

As the food is being chewed, it is at the same time mixed with the *saliva* or spittle. This saliva is the first of the digestive fluids.

The mucous membrane of the mouth is dotted over with minute tubules, called "buccal glands." These tubes are lined with extremely minute cells. The spittle or saliva is not a simple fluid. It consists of four distinct fluids. The buccal glands pour out a quantity of mucous, which mixes with the secretions which come from the *parotid*, *submaxillary*, and *sublingual* glands. The latter glands exist in pairs. Each parotid gland lies in front of the ear, and behind the angle of the jaw; and its duct opens into the mouth opposite the second grinder tooth of the upper jaw. The submaxillary glands and sublingual glands are placed in the floor of the mouth, and they pour their secretions into the mouth through two little openings which lie under the tip of the tongue, behind the front teeth of the lower jaw. These three glands swell up to a great size when a child has the mumps.

The saliva is a thin watery fluid, and contains in solution a small quantity of a remarkable substance called *ptyalin*, which possesses remarkable properties.

It does not affect in the least nitrogenous food or fats; but if mixed with starch and kept at a warm temperature, the saliva in time will convert starch into grape sugar. Starch is quite insoluble and useless as nourishment, but when acted on by

saliva it becomes a highly soluble and nutritious form of sugar called grape sugar. How is this saliva manufactured? It is poured out to the extent of about $1\frac{1}{2}$ lbs. in twenty-four hours.

The parotid and submaxillary glands and sublingual glands are good examples of what are called *racemose* glands. They are in general form like a small bunch of grapes. The main stalk represents the duct by which the secretion enters the mouth. The parotid gland consists of a great number of little sacs or bags, and each little bag is lined with a layer of extremely minute cells. Each little bag has on the outside of it an immense number of little bloodvessels. When the parotid gland is secreting its fluid, the little cells lining the bags or sacs imbibe from the blood circulating around them such material as they require, and they manufacture it into saliva. We cannot make them do this, nor can we prevent them forming saliva by any effort of our will. The mere presence of food in the mouth causes these little cells to begin their work. The smell of a delicious dish is sometimes sufficient to make them pour out their secretions, and then the mouth "waters," as we express it. The saliva formed in each little bag is poured out into the main duct or channel, and through this into the mouth. Thus during the chewing of food, spittle is being poured into the mouth by the buccal glands, by the parotid, submaxillary, and sublingual glands. When first poured out this saliva is alkaline. Besides acting on the starchy elements of food and converting them into soluble sugar, the saliva keeps the mouth constantly moist. It also dissolves sugar and salt, which form part of our food; and it also makes the chewed food slippery and easily swallowed.

It is important that you should know that these salivary glands are not active in the child until the age of four or six months. Hence to give a child of such an age much starchy food, such as arrowroot or corn flour, means to poison it. I have frequently seen children at this tender age suffering from diarrhoea and other troubles of the digestive system brought about by starchy food, which the poor child was quite unable to digest.

When the food is thoroughly chewed and mixed with saliva it

is carried backwards by a semi-involuntary movement of the tongue, which at the same time presses down the epiglottis over the entrance into the windpipe, and the bolus of food is pushed into the commencement of the *œsophagus* or gullet, where, by the muscular action of the coats of the tube, it is carried down into the stomach.

Drink is taken in the same way. We must not suppose that the bolus of food and the gulps of water simply drop down from the back of the mouth into the stomach. This is not the case. Each mouthful is pushed backwards by the tongue, and then it is grasped by the muscular coats of the gullet and pushed down into the stomach. It is by means of this muscular action of the gullet that jugglers are able to eat and swallow food and drink while standing on their heads, and by this means the ox or the horse is able to drink water while its head is lower than its stomach.

THE GULLET.

The gullet or *œsophagus* is a tube about nine or ten inches in length. Above it is continuous with the *pharynx*, whose mucous membrane is continuous with that lining the back of the mouth. The gullet passes down immediately behind the windpipe, through the chest, and then passing through the diaphragm it at once becomes connected with the stomach near its large dilated cardiac end. I remember, when I was a boy, being told that a whale could not swallow a man, because its swallow or gullet was so small. It was supposed, because the whale fed upon small fish and extremely minute creatures in the sea, that therefore it must have a small gullet. It fell to my lot some years ago to dissect the large whale which, you may remember, was thrown on the shore at Longniddry and then towed across to Kirkealdy, and I made a point of ascertaining the exact size of the gullet. Now, without giving you the exact figures, I may tell you that a man could pass down the whale's gullet just as easily as he could slip down the barrel of one of Sir William Armstrong's 100-ton guns! If the whale which was said to have swallowed Jonah was anything like the whale which I cut up, all I can say is Jonah must

have had a very uncomfortable time of it, for in our whale's stomach there was about two tons weight of herrings and cod-fish, mixed up with no end of fish bones and several gallons of rancid oil. It is right, however, to say we are not told it was a whale that swallowed Jonah, but "a great fish." A whale is not a *fish* at all, but belongs to the class of animals to which man belongs. It is a mammal, and gives suck to its young one. No fish does that.

Every organ of digestion within the abdomen is invested by the *peritoneum*, a delicate membrane which lines the whole cavity of the abdomen, and then passes over every organ, giving a covering to each, and serving to bind them in their places.

THE STOMACH.

The stomach may be described as a large dilated tube, very like the bag of a bagpipe. One end of this dilated tube is much more blown out than the other end. This widely dilated part of the stomach is called the *cardiac* end, because it lies up against the under surface of the diaphragm, just under the heart. When the end of the stomach is full of wind the heart is often pressed upwards by it, and beats more powerfully against the chest wall, making a person believe he has some serious affection of the heart. The right end of the stomach gradually tapers off, and becomes continuous with the small intestine. Just before the stomach joins the intestine there is a valve, known as the *pyloric* valve, and the portion of the stomach near it is called the pyloric end of the stomach. The first part of the intestine in connection with the stomach is called the *duodenum*.

When the stomach is well filled it measures little more than twelve inches in length, and its greatest diameter is about five inches. If cut open and spread out like a handkerchief it would cover a space $1\frac{1}{4}$ feet square. The stomach does not lie straight across the upper part of the abdominal cavity. The bulged out cardiac end lies close against the under surface of the diaphragm on the left side, but the pyloric end of the stomach is situated much lower down on the right side, just below the margin

of the ribs. From the lower border of the stomach there hangs down a beautiful membrane, known as the *omentum*, which serves as a protection to the coils of intestine which are beneath it.

Underneath the peritoneal coat of the stomach there are two muscular coats—an external and an internal muscular coat. The fibres of the external muscular coat run along from the cardiac end to the pyloric end of the stomach, while the internal muscular fibres wind round the stomach something like the hoops round a barrel. But the most wonderful part of the stomach is its mucous membrane.

The mucous membrane covering the tongue lines the back of the mouth, then passes down the gullet, then lines the whole of the stomach, and then lines the whole of the intestines. We doctors are continually looking at the tongue of our patients; why do we so? It is not to tell us how the tongue itself is, but to tell us how the mucous membrane of the stomach and intestines is. There is a wonderful sympathy between all parts of the mucous membrane, throughout the entire alimentary canal, and when one part is out of order, sooner or later the mucous membrane of the tongue will get out of order too; so by examining the tongue carefully we often can tell how the mucous membrane of the stomach and intestines is. I told you that the mucous membrane of the mouth was everywhere studded with buccal glands. So the mucous membrane of the stomach is everywhere studded with very remarkable tubular glands, whose duty it is to pour out the gastric juice during the digestion of food. When digestion of food is not going on the mucous membrane of the stomach is of a delicate pink colour, and is arranged in longitudinal folds; when the stomach is distended with food these folds disappear.

If we examine a portion of the mucous membrane of the stomach near its cardiac end with an ordinary lens or magnifying glass, we find that its surface presents a peculiar honeycombed appearance, produced by shallow, many sided depressions or pits. In the bottom of these pits are the openings of little tubes which lie side by side, and arranged in a perpendicular manner. Each

little tube is lined by a great number of little cells, which have the power of abstracting from the bloodvessels which lie in the wall of the stomach the materials out of which they make the gastric juice. Each little tube has a number of minute bloodvessels round about it in close contact with it, so that the cells lining the tube can easily imbibe from the blood the materials they require.

GASTRIC JUICE.

These *peptic* glands, as they are called, when food is taken into the stomach, pour out a thin acid liquid called the *gastric juice*, which owes its acidity to the presence of hydrochloric or lactic acid. The gastric juice also contains a very remarkable substance known as *pepsin*. You remember that the cells lining the little sacs of the salivary glands poured out a thin liquid, which is alkaline, during the time the food is being chewed.

When food such as bread and meat, &c., is undergoing digestion in the stomach, the contractions of the muscular coats of the organ roll the food about, and at the same time the gastric juice is being constantly mixed with it.

During the years 1825 to 1832, Dr Beaumont of the United States Army made a great number of observations on the process of digestion. He was fortunate in having a man exactly suited for his experiments. This man's name was Alexis St Martin. He was a Canadian boatman, who had an opening into the cardiac end of his stomach caused by the accidental discharge of a gun. The gun which shot St Martin was loaded with buck shot, and blew away a large piece of the wall of his chest, and made a big hole in the cardiac end of his stomach. This terrible wound healed, but there was left an opening in the skin, which communicated with the interior of the man's stomach. Dr Beaumont used to look into the man's stomach while digestion was going on; and he found out that gastric juice was poured out only when food was in the stomach. Immediately after food is introduced into the stomach, the delicate pale pink mucous membrane becomes red and turgid with blood, and there appear everywhere little minute drops of gastric juice, just like the drops of sweat on a

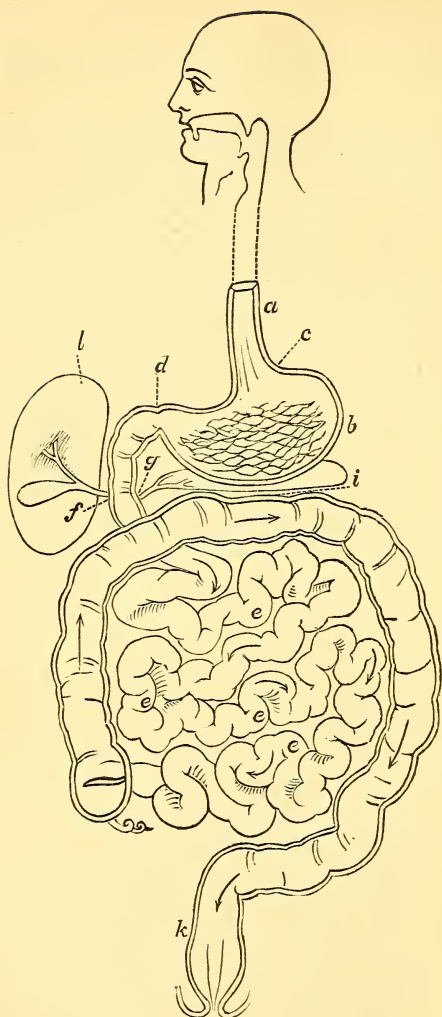
man's brow. These drops gradually run together and flow down the wall of the stomach to soak into the substance of the food.

Dr Beaumont used to put a tube into the man's stomach, and suck out a quantity of the gastric juice, with which he experimented; and he found that if he mixed the juice with meat or white of egg in a glass, and kept it at the temperature of the body, it would digest these substances nearly as quickly as if it were in the stomach. He also used to tie pieces of different kinds of meat on a string, and then pop them into the man's stomach; at different times he pulled out the strings, and noticed how far digestion of the various meats had proceeded. As the result of such experiments, he found that tripe was digested at the end of one hour; roast beef at the end of three hours; roast mutton at the end of three hours and a half. Salt beef took four hours and a quarter, while roast pork took five hours to digest. He also told us that roast turkey was thoroughly digested at the end of two hours and a half. Not many of us get a chance of trying our digestions on roast turkey!

Now, gastric juice will not digest every kind of food. It affects only a single class of food, namely—the nitrogenous food, such as meat and albumen of white of egg, the gluten of bread, the casein of cheese, and such like. It has no effect on starch, or oils and fats; but solid and semi-solid nitrogenous foods are at once attacked and liquified by the gastric juice.

This power of digesting nitrogenous foods depends upon the presence of pepsin and acid in the gastric juice. The effect of digestion in the stomach is to convert the food into *chyme*, which is always a thick liquid, like gruel or thick pea soup, and has a strong disagreeable acid smell and taste. The quantity of gastric juice varies from 10 to 20 pints in twenty-four hours.

The real and important action of gastric juice is to convert the nitrogenous foods into such a state of solution that they can readily pass through the delicate walls of the bloodvessels in the walls of the stomach and intestines. All nitrogenous foods are converted into *peptones*. These peptones always contain nitrogen. When nitrogenous foods have been converted by the action of



Course of food
indicated by
Arrow.

HUMAN ALIMENTARY CANAL.—*a* Œsophagus. *b* Stomach.
c Cardiac orifice. *d* Pylorus. *e* Small intestine. *f* Biliary duct
g Pancreatic duct. *h* Ascending colon. *i* Transverse colon.
j Descending colon. *k* Rectum. *l* Liver. *p* Pancreas.

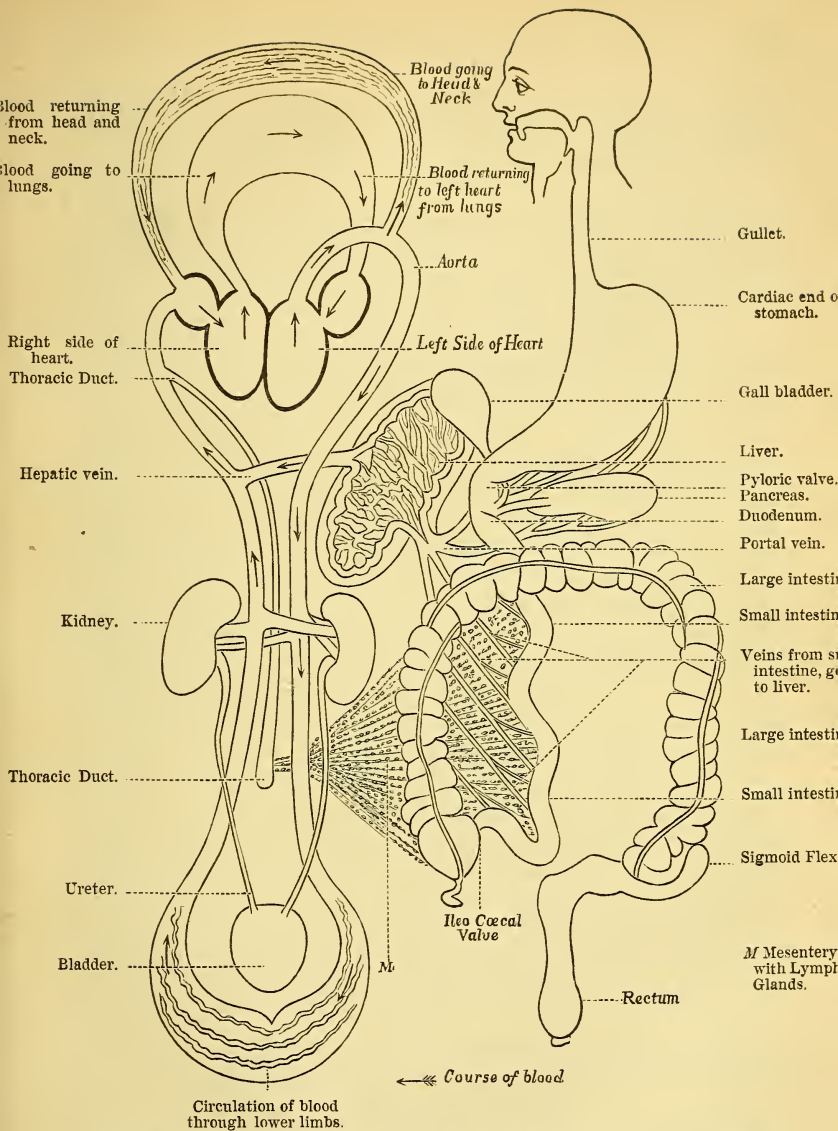


Diagram showing the relation of the Digestive System to the Circulatory System.

gastric juice into peptones, the latter are easily absorbed into the blood, which they were not before being acted on by the gastric juice. Meat, eggs, milk, cheese, &c., are converted into soluble peptones.

Mixed up with the meat we eat there is always a lot of starchy food, such as exists in the potato and bread, and there is always some fat or oily matter in our ordinary diet. On these substances the gastric juice has not any action. They must be attacked and digested by other fluids before they can be absorbed.

Salt and sugar are dissolved by the gastric juice, and may pass at once with the soluble peptones into the bloodvessels in the walls of the stomach.

One remarkable character of the gastric juice, besides those mentioned, is, that it has the power of correcting and preventing putrefaction. Many men like game, "high," as it is called; such flesh is always in a state of putrefaction. The gastric juice corrects this, or else disease would result from eating such flesh. Such starchy material as was well digested by the saliva, along with sugar and salt, is rapidly absorbed by the bloodvessels of the stomach; but there is always a considerable quantity of starchy food that has escaped the action of the saliva.

Digestion of starchy food by the saliva in the stomach is put a stop to by the acid gastric juice, which renders the saliva powerless by neutralising it. All the time digestion is going on the pyloric end of the stomach is tightly closed, but towards the end of digestion the contractions of the stomach squeeze the chyme through the pyloric valve, and it then passes into the intestines. Only a small quantity of the soluble peptones are taken up by the bloodvessels of the stomach. A very large quantity of these rich nutritious peptones are taken up by the bloodvessels in the wall of the intestines, and from thence passed into the blood.

Man does not "chew his cud." I know a gentleman, however, at the present moment, who can bring up food from his stomach into his mouth at will, and chew it over again.

And now we have to consider what takes place after the digested food has passed out of the stomach into the intestines.

INTESTINES.

The first part of the intestinal tube is called the *duodenum*. It is about 10 inches in length. In man the intestinal canal is about 25 feet in length.

As a rule in flesh-eating animals it is short, and in vegetable-eating animals it is long. In the sheep it is 30 times the length of the animal itself, while in the giraffe the intestine is about 134 feet in length.

The length of the alimentary canal in grass-eating animals is probably owing to the low nutritious character of the food they eat.

The intestinal canal of man is divided into large and small intestines. These two are continuous with each other. The small intestine communicates with the large intestine by means of the *ileo-cæcal* valve, which allows the food to pass from the small intestine into the large intestine, but does not allow it to go in the opposite direction.

The intestinal tube, like the stomach, is covered over by the peritoneum. By means of this covering the coils of the small intestine hang down from the backbone into the cavity of the abdomen. The peritoneal membrane which thus supports the coil of the intestine is called the *mesentery*. It is a double layer, and between the folds are an immense number of bloodvessels, nerves, and lymphatic glands and vessels.

The intestinal canal, like the stomach, has four coats—the peritoneum, the external and internal muscular coats, and the mucous coats; all these structures are continuous with the similar structures of the stomach. The muscular fibres of the external coat run in the direction of the tube of the canal, while the fibres of the internal muscular coat surround the mucous membrane like the hoops of a barrel.

In the mucous membrane of the duodenum are numerous glands called the *glands of Brünner*. They are like little salivary glands, only very small, and they pour out a fluid which mixes with the chyme after it has passed through the pyloric valve of the stomach.

Throughout the entire mucous membrane of the small and large intestine there are imbedded an immense number of small tubes called the *follicles of Lieberkühn*. Each little tube is about the $\frac{1}{320}$ of an inch in diameter, and about five times as long as it is broad. These minute tubes are lined with extremely small cells, which pour out a peculiar fluid called intestinal juice, just in the same way as the glands of the stomach pour out the gastric juice. Now this intestinal juice has the wonderful power of acting on starchy foods in such a way as to convert them into soluble sugar, so that the starchy foods which escaped digestion in the mouth and stomach are now digested by the intestinal juice.

Perhaps the most important structures in the small intestine are the *villi*. On placing a small piece of the mucous membrane in a little water it will be seen to have a velvety appearance; this appearance is caused by the presence of an immense number of minute conical projections of the mucous membrane known as villi. These villi vary in size from the $\frac{1}{40}$ th of an inch to the $\frac{1}{12}$ th of an inch, but some are not more than the $\frac{1}{120}$ th part of an inch in diameter. They cover the whole surface of the mucous membrane.

From the duodenum down to near the end of the small intestine the mucous membrane is arranged in transverse folds, which go nearly round the tube of the intestine. These folds are called *valvulae conniventes*. They increase enormously the extent of the mucous surface, and as the villi cover the *valvulae conniventes* as well as other parts of the mucous membrane, some idea may be formed of the great extent of surface there is in the small intestine. It has been calculated there are more than 4,000,000 villi on the surface of the mucous membrane of the small intestine.

The villi have a remarkable structure. Each contains a small artery which breaks up into many small veins, which end in one or more larger trunks, and then pass out of the villus again. In the middle part of the villus is a whitish-looking tube, called a lacteal vessel, which is an offshoot from an immense number of minute lacteal tubes imbedded in the submucous coat of the small intestine. As will be afterwards explained, the lacteal

vessels absorb the fatty portions of food as they pass along the intestine.

The villi hang down from the intestinal mucous membrane, and as the food passes onwards they suck up the liquified portions of it with astonishing rapidity. The rapidity with which they absorb depends very much on the rapidity of the circulation of blood through the small bloodvessels in their interior. By the contraction of the muscular coats of the intestine, the digested food is squeezed onwards, and at the same time the villi are pressed against the passing food, and in this way they are better able to absorb the liquified portions of it. They absorb soluble peptones, soluble sugar, and a certain amount of emulsified fats and oils. The lacteals, however, absorb the greater proportion of the fats when digested. By this wonderful process of absorption the liquified and digested food is taken up by the minute bloodvessels in the villi, and then the veins in each villus convey blood saturated with nourishment into the larger veins which lie between the folds of the mesentery. These latter veins gradually converge upwards to a large vein called the *vena portæ*, which enters the liver at its under part.

At the end of the small intestine there remains little else but the indigestible portions of the food and the refuse of the intestinal secretions. These pass through the ileo-cæcal valve into the large intestine, where they are further acted on by the secretions from the large intestine, and anything that is nutritious is absorbed, while the rest is cast off from the body as useless material.

While the food is passing through the duodenum, it is mixed with the bile which comes from the liver, and with the fluid which is secreted by the pancreas.

THE PANCREAS.

The *pancreas* is a long, flattened gland, about eight inches in length, and one and a half broad, and nearly an inch in thickness. It lies right across the back bone in front of the large bloodvessel called the *aorta*, and its duct opens into the duodenum near its

lower part. In structure it is like a salivary gland. The fluid secreted by the pancreas has the wonderful property of converting fats and oils into a complete emulsion, by which means they are readily absorbed by the lacteals of the villi, and by the small bloodvessels.

This power of emulsifying fats and oils depends on the presence of a peculiar substance, named *pancreatine*, in the pancreatic fluid. Pancreatic fluid also has the power of converting starch into grape sugar.

THE LIVER AND BILE.

The *bile* mixes with the food in the duodenum just at the point where the pancreatic fluid was poured into the intestine. When freshly poured out, it is of a yellow or reddish colour. It has a strong, bitter taste, and it is neutral or slightly alkaline in its reaction.

The process of secreting bile is continually going on, but it is formed very slowly when one is fasting; when food is being digested, the bile is poured out in large quantity. The amount of bile poured out into the intestines varies according to the amount of food taken, but on an average there is secreted from 30 to 40 ounces in 24 hours.

The bile is formed in the liver by the liver cells. The liver itself weighs between 50 and 60 ounces. It is situated on the right side of the abdomen, and fits up against the under surface of the diaphragm on the right side, just as the cardiac end of the stomach fits up against the under surface of the diaphragm on the left side. It should not be felt below the margin of the ribs on the right side. It has a coat of peritoneum which binds it in its place.

It consists of an immense number of small *lobules* about the twentieth of an inch in diameter, which from mutual compressure have a polygonal shape. Now, each of these lobules consists of an immense number of minute cells, called hepatic or liver cells, whose duty it is to secrete the bile. They vary in size from the $\frac{1}{800}$ th to the $\frac{1}{1000}$ th of an inch in diameter, and from being pressed together they are polygonal in outline.

These little liver cells extract from the blood the material out of which bile is made, just as the cells in the peptic glands extract from the blood the material out of which the gastric juice is made. In each lobule there is an extraordinary capillary network of minute veins, which come from several branches or offshoots from the large vena portæ. Now you remember the vena portæ is the large trunk formed by the union of all the veins coming from the stomach, pancreas, and intestines. It is a large vein which enters into the liver on its under side, and conveys to the liver the blood which comes from all the organs of digestion, and this blood is loaded with the absorbed products of digestion.

This vena portæ gives off numerous small branches which pierce each lobule, and then split up into an extraordinary mesh of extremely small veins. In the mesh work thus formed lie the little liver cells. By this arrangement the liver cells are brought into close contact with the blood, as it flows through the minute veins; and they are thus better able to imbibe from the blood the materials they require to manufacture into bile.

After the bile has been manufactured from the blood by these little liver cells, it is passed into small vessels or tubes called hepatic or *bile ducts*, and these convey it to the bag called the gall or bile bladder, and in this bag it is stored up when digestion is not going on; but when digestion is going on, the bile is constantly poured out into the intestine, as I have described. But what becomes of the blood in the extraordinary mesh-work of veins after the liver cells have done their work? Why, in each lobule it is again collected into one small venous trunk, which leaves each lobule, and then joining a great number of other such trunks, all together form one large vein called the hepatic vein, whose duty it is to carry the blood thus deprived of the elements of bile into a large vein, the inferior vena cava as it is called, leading directly to the right side of the heart. From the right side of the heart the blood is pumped to the lungs to be further purified, where we shall leave it for a short time.

Please do not suppose that the bile is brought to the liver ready made and then extracted by the liver cells. It is not so. The blood which enters the liver by the portal vein contains no bile, but

this fluid is entirely manufactured by the minute liver cells, in very much the same way as the other secreting cells in the different glands manufacture their secretions. It is indeed a wonderful process. In these liver cells lies the power of extracting such material as they require for the manufacture of bile. The bile is very rich in hydrocarbons—that is, substances composed of the elements hydrogen and carbon. Thus a piece of dried bile will readily burn away if lighted in a flame. As a rule no bile is to be found in the blood, but sometimes the mucous membrane of the duodenum in the neighbourhood of the gall bladder's orifice becomes swollen and inflamed. Then the duct of the gall bladder, which has a very small opening, gets blocked up, and the bile, somewhere behind the point of obstruction, is apt to be absorbed into the blood. When there is bile in the blood the white of the eye at once shows a yellow tinge, and the skin may become as yellow as a guinea. The person thus affected is then suffering from *jaundice*.

Now for what use is the bile? It is important to remember that it is poured into the intestine at its upper part, so that it mingles with the chyme directly after it leaves the stomach. Now this arrangement clearly shows that the bile has some important relation to the food with which it is mixed. There is little doubt that the bile is, in the first place, an excretion—that is to say, the bile is the means of purifying the blood coming from the organs of digestion. It takes from the blood a large quantity of impurities which, if they passed on into the general circulation, would be injurious to the body. The liver is placed as a filter between the organs of digestion and the right side of the heart, and without doubt, one of its chief duties is to filter the blood of those materials which collectively make the bile. But the bile, when once formed, has important digestive functions, of which the chief are—

- 1st. It assists in emulsifying the fatty portions of the food, and thus makes them more easily absorbed by the lacteals in the villi.
- 2d. By moistening the mucous membrane of the intestines the fatty matters of the food are more readily absorbed.

3d. It has a marked antiseptic power like the gastric juice.

When thoroughly mixed with the food it prevents its decomposition, and the formation of gas in the intestine.

4th. As it passes down the intestine it seems to stimulate the follicles of Lieberkühn to pour out their secretions more copiously; and it also stimulates the muscular coats of the intestine to contract, and thus to drive onwards their contents.

After the bile has done its duty in assisting digestion, it undergoes some peculiar changes in composition, and is re-absorbed into the blood, and being a highly hydrocarbonaceous material it is oxidized, and by its combustion helps to maintain the heat of the blood.

But there is another wonderful function performed by the liver, and that is the formation of a substance which readily is converted into grape sugar. A Frenchman, Claude Bernard, 1848, after a number of experiments, found that a substance named "glycogen," or "sugar former," was manufactured in the liver cells, and that this substance rapidly became converted into sugar, and passed into the blood in the form of grape sugar, and by the oxidation of this sugar in the lungs the heat of the body is kept up.

This formation of glycogen in the liver is a normal process, and so is its rapid conversion into sugar. Sometime so much sugar is thus poured into the blood that some of it appears in the secretion from the kidneys, constituting the disease called "Glycosuria." The well-known disease *Diabetes mellitus*, in which a large quantity of sugar is daily found in the secretion from the kidneys, has some close relation to the normal glycogenic function of the liver.

Let me now, in conclusion, give a summary of the changes which take place in the food during its passage through the stomach and small intestine. In the stomach the food is thoroughly mixed and converted into a uniform mass. It is saturated with the gastric juice which dissolves the nitrogenous portions of it. The conversion of the starchy food into sugar, which began in the mouth, is now almost stopped in the stomach, and the

fatty matters are thoroughly mixed up with the other constituents of food, but as yet they are not digested in the least. Soluble matters, such as sugar and salt, and those substances which have been rendered soluble by the action of saliva and the gastric juice, have begun to be absorbed by the bloodvessels in the wall of the stomach, and such fluids as wine and water also begin to disappear. That thick pea-soup liquid, the chyme, which results from the gastric digestion, is being continually squeezed through the pylorus into the duodenum. It consists of nitrogenous matters broken down and half dissolved, fatty matters broken down but not dissolved at all, starchy matters being slowly converted into sugar, and being dissolved in the fluids in which they are mixed as soon as they are converted into sugar. When it passes into the duodenum, the chyme is further mixed with fluid secreted by Brünner's and Lieberkühn's glands, and then with the bile and pancreatic juice. Now all these liquids have a more or less alkaline reaction, and by being mixed with the chyme the acidity of this latter becomes less and less, until, at the middle of the small intestine, it is decidedly alkaline in its reaction. In the upper part of the small intestine the fatty parts of the food are converted into an emulsion—that is, fat is converted into exceedingly minute particles, which are readily absorbed.

Those nitrogenous substances which were partly dissolved in the stomach are still further acted on by the gastric juice, and they are converted into soluble peptones, which are capable of easy absorption. The starchy constituents of the food are now rapidly acted on by the pancreatic and intestinal juices, and the sugar thus formed is quickly dissolved in the fluids, and is absorbed chiefly by the bloodvessels of the villi. The fatty emulsions are absorbed chiefly by the lacteals in the villi. As this fatty emulsion flows through the lacteals into the larger lacteal vessels it is called *chyle*. The epithelial cells covering the surface of the villi seem to pick up the minute fatty molecules and then pass them on into the lacteal vessels. The chyle flows in the lymphatic or lacteal vessels through the mesentery, and then is acted on by the lymphatic glands, which are very numerous in this situation. As the chyle leaves the mesenteric glands it

is much altered in physical characters, and contains a number of corpuscles, which gradually pass into blood corpuscles.

The chyle at last passes into a long tube, called the *thoracic duct*, which leads into the large veins entering the right side of the heart. In this way the fatty emulsified foods are carried into the blood, and there they become saponified or converted into a soapy material, which diffuses thoroughly with the blood. Those nutritious substances which have been absorbed by the blood-vessels of the stomach and intestines pass in the veins up towards the liver, and as the blood, rich in nutriment, passes through the liver, bile is manufactured from it, and the blood is thus purified. The blood then passes into the inferior vena cava, and then into the heart, from whence it is pumped to the lungs. Here it is acted on by the oxygen of the air. A large quantity of carbonic acid and watery vapour is excreted, and the blood, rich in nourishment and purified, is now sent by the contractions of the left side of the heart all through the body. It flows from the large bloodvessels into the smaller ones, and then into the myriads of minute capillaries. Here the cells or ultimate structures of each tissue, such as bone, brain, muscle, &c., abstract or imbibe from the blood the materials they require for their nutrition, and for the performance of their functions. Thus the cells of the brain extract material from the blood, and there can be no doubt that if they did not get the material they require there would be no manifestations of mind. The muscles and bones and different organs of the body take only the materials they require. Recollect it is the minute cells in each tissue that select these materials, and that before they can do so the blood must be spread out into the millions of capillaries which permeate every tissue. While the blood is thus giving out nourishment for the nutrition and growth of the various tissues of the body, it also takes in the effete or used up material, the ashes, as it were, that remain after work has been done, and passing onwards loaded with impurities it arrives again at the lungs, where carbonic acid and moisture are again thrown off. It arrives at the skin, where much moisture and animal matters are thrown off, and as it circulates through

the kidneys a large quantity of the effete nitrogenous materials is thrown off in the form of *urea*.

It is the minute cells in the different tissues and organs of the body that do all the work. They require to be well fed. The object of the circulation of the blood is to take nourishment to them, without which they could not work. All work implies waste. The circulating blood while it feeds the cells takes from them the waste materials. The waste materials consists chiefly of hydrogen and carbon. These are got rid of from the blood by breathing fresh air or oxygen, and by taking plenty of exercise, by which means an enormous quantity of carbonic acid gas, with moisture and animal matters, is thrown off from the blood.

In conclusion, compare the original germ or egg with man as we have now seen him. What a wonderful change. And yet every tissue of his body is made up of cells, which are the descendants of the original germ. Can you wonder at my endeavour this evening to fix your attention on the marvellous powers of these small cells? Do all you can to live strictly in accordance with the best rules of health. Try to preserve the lives of these little cells by living temperately, with due regard to exercise and cleanliness. And never forget that your life is made up of the lives of these little cells, and if they perish you perish also.

SMALL-POX AND VACCINATION.

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BY D. RUTHERFORD HALDANE, M.D., *P.R.C.P.*  
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WE are all more or less painfully aware that we are subject to a variety of diseases, though the causes which give rise to them are often very obscure. Diseases do not occur spontaneously ; if no morbid causes were in operation the organism might go on working smoothly until it was worn out, for I need not say that the body is only designed to have a limited duration. But as a machine is exposed to a variety of accidents which may affect its acting, and lead to its derangement, so the body is surrounded by causes of disease. If we had not a certain power of resisting these causes, we should be constantly ailing, and there are great differences in the power of resisting, not only between different individuals, but in the same individuals at different times. This greater or less power of resistance constitutes what is called the lesser or greater susceptibility to disease.

The causes of disease may be divided into two great heads, the general and the specific. The general causes are those which are constantly in operation around us, which do not act unless they are in a certain degree of intensity, and which often act rather by weakening the body and making it more susceptible, than by producing any definite disorder. Among these general causes we include age, sex, occupation and mode of life, climatic and atmospheric influences, and the like. As an illustration of the mode of action of these general causes, let me take a familiar example ; what do we mean by catching cold ? A person is said to have caught cold when, after exposure to a lowered temperature, combined usually with the chilling influence of air in motion, and often aided by a moist atmosphere, removal of heat from the sur-

face of the body has taken place to an unusual degree, and when in consequence a disorder, trifling or severe, has been set up. Now it is not the cooling of the surface which is the direct cause of the disease, for the effects are not usually local, but show themselves in remote situations. Suppose several people sit in a draught; of these, a certain proportion, probably the majority, will escape altogether; of the rest, some may suffer from sore throat, earache, toothache, or rheumatism; others from feverishness, catarrh, pleurisy, or some other internal inflammation. It is evident that there has been nothing specific in the cause, for it has given rise to very different symptoms in different individuals. What has taken place appears to be this. When the skin is exposed to a sufficient degree of cold for a sufficient length of time, a peculiar impression is made on the nerves of the part, of which impression the individual may or may not be conscious; this impression is conveyed along the nerves to the centres in the brain and upper part of the spinal cord, and is then reflected, as it is called, along other nerves to various parts of the body. Now the effects will vary according to the susceptibility of the individual. If there is a susceptibility of his sensory nerves, this will show itself in rheumatic pains or neuralgia; if of the nerves of the bloodvessels and of nutrition, in various congestive or inflammatory affections; if the susceptibility be in the centre which regulates heat, fever may result. It will thus be seen that cold has not produced any uniform or specific effect; the effects upon different persons have varied according to their susceptibility, that is to say their greater or less power of resistance. The other general causes of disease act in essentially the same way.

With the specific causes of disease it is different. These are of the nature of poisons, and if they act at all, act always in the same way; the symptoms produced by them may vary in severity, but not in character. But there is one very remarkable peculiarity which distinguishes them from the ordinary poisons of the vegetable and mineral kingdoms. The effects of an ordinary poison depend essentially upon the amount introduced into the system, and they are in fact not poisons at all unless a certain minimum dose has been exceeded. Thus, many of the most

energetic poisons, such as opium, arsenic, prussic acid, strychnia, and others, are in small doses most valuable medicines, and it is only when the dose is increased beyond a certain point that we get dangerous effects. As soon as a poison is introduced into the body, nature endeavours to eliminate it, and within certain limits will be successful in doing so; but if the quantity has been too large, the organism is overpowered, and death is the result. The specific animal poisons act in a different way; the amount of the poison taken into the system makes little or no difference on the effect produced, as the virus possesses the property of multiplying itself almost indefinitely. When an unprotected person is exposed to the poison of small-pox, he inhales a certain amount of air containing emanations from the sick person. The poison almost certainly exists in the form of very minute bodies floating in the air, so minute as to elude our most delicate means of research. At first no apparent effects are produced in the recipient of the poison; he may go about as usual; he may entirely forget his exposure to the disease; and it will not be until after an interval of ten or twelve days that he feels really ill. During this time, which is called the latent period, the poison has been going on multiplying within the system, and it is only when the development has proceeded to a certain extent that definite symptoms show themselves. Of the extent to which the poison has multiplied we can scarcely form an idea. The amount of the small-pox poison originally introduced was infinitesimally small, but in a bad case when the disease is at its height, the patient is covered from head to foot with countless pocks, from any one of which several persons might be inoculated; all his secretions are tainted; the atmosphere around him is teeming with the poison which is being constantly given off.

Another great peculiarity of these specific diseases is that one attack generally protects a person from the recurrence of the same disease. We know that comparatively few persons have small-pox, measles, scarlet fever, or whooping cough a second time. This is explained in the following way: in most persons there naturally exists in the blood a something which makes it a suitable soil for the multiplication of the poison; but when this multiplication has

once taken place, that is when the person has gone through one attack of the disease, this something is destroyed, and unless it is again formed, which is always a tedious process, the person is insusceptible to a recurrence of that disease. You know in a general way what takes place in ordinary fermentation, such as the making of beer. The barley is first malted, and during the process a large quantity of sugar and starch is formed. The malt is ground or bruised, and by the action of warm water all the soluble matter is extracted. To this solution or wort, yeast is added, and very soon the fluid passes into a state of commotion or fermentation, much gas is given off, a large amount of new yeast is formed, and the sugar of the wort is converted into carbonic acid and alcohol. The process of fermentation comes to an end so soon as all the sugar has been so converted, and it is evident that it could not be again set agoing unless a fresh quantity of sugar were added. Yeast, I may state, is a substance in a state of change, containing an immense number of microscopic vegetable cells, which are undergoing rapid growth. When the yeast is introduced into the wort, the growth of cells goes on more rapidly, for their development is an essential part of the process. After a time this cell growth reaches a climax, then declines, and at last dies out. All this is very analogous to what occurs in the case of the specific poisons; there exists in the blood something analogous to the sugar in the fermentable fluid; the poison corresponds to the yeast and multiplies within the body until the whole of the *something* has been destroyed or converted; and when this has once taken place it can only be renewed, if ever, after the lapse of a long time.

The last peculiarity I shall mention with regard to the specific diseases is, that each of them is produced by a special poison, that they are propagated by infection or contagion, and that so far as we know the poison is never spontaneously produced; that is to say, while the vast majority of diseases such as inflammations and the like may be produced by a variety of causes, small-pox and the other specific diseases can only be produced by the communication of the poison from the sick to the healthy. It is often difficult or impossible to trace the communication, but when it is

borne in mind that the poison exists in an almost impalpable form, and that it may under certain circumstances retain its properties for an almost indefinite period, our difficulties with regard to exceptional cases will disappear.

I fear I have wearied you by these somewhat abstract considerations, but I hope they may prove conducive to the better understanding of the proper subject of my lecture, upon which I now proceed to enter.

Of the specific diseases of which I have been speaking, small-pox is the most important, although fortunately its ravages are far more limited than they were prior to the introduction of protective measures. It seems quite unnecessary for me to give any description of the disease, but I have no doubt you are all aware that it is one of the most dangerous and loathsome maladies which afflict mankind. Of the origin of small-pox we know little or nothing; it appears, however, to have come from the East, and to have been known in China and Hindostan from time immemorial. It is said that in India, long before the Christian Era, a particular goddess had been worshipped as a protectress against it. The disease slowly travelled westwards, for communication was very tardy in those days, and it seems to have reached Constantinople by way of Egypt about the year 569, the year of the birth of Mahomet. From Constantinople it spread gradually over the whole of Europe, having reached England about the middle of the thirteenth century, while Sweden was not visited till two hundred years later.

In Europe small-pox long constituted one of the greatest scourges of the inhabitants, and in the present day we can have no idea of the terror with which it was regarded. It was more dreaded than the Plague, and the treatment of the disease previous to the time of the great English physician Sydenham, was not calculated to diminish the mortality. The treatment consisted in endeavouring to "drive out the poison," in encouraging perspiration by enveloping the patient in thick flannel, in carefully excluding every breath of fresh air, and in the administration of hot drinks.

In the eighteenth century, when the population was much

smaller than at present, it is calculated that 500,000 died of it in Europe annually. In France the annual mortality was 80,000 ; in England, 7 to 9 per cent. of all deaths were attributable to it. A good illustration of the prevalence of small-pox is afforded by a proverb well known at that period, "From small-pox and love, but few remain free."

The ravages of the disease were still more terrible when it was for the first time introduced into a new country, especially if that country were within the tropics. Small-pox was unknown in America at the time of its discovery by Columbus in the year 1492 ; it was introduced by the Spaniards, and first showed itself in Mexico in 1527, and is said to have cut off at that time three millions and a half of the inhabitants. Thence it gradually overran the whole of America. It is believed that nearly one-half of the North American Indians were cut off by it ; powerful tribes were almost exterminated. Perhaps a still better idea of the malignancy of the disease may be obtained by observing how many deaths it caused among the royal families of Europe, who, it is reasonable to believe, were surrounded by all known precautions against it. Joseph the First of Austria and Mary Queen of England died of it ; and in the course of the eighteenth century it cut off two empresses, six archdukes and archduchesses, an Elector of Saxony, and the last Elector of Bavaria.

When the terror regarding small-pox was at its height, news came to this country that in Turkey a means was known for moderating the severity of the disease. This means was inoculation, and consisted in taking a little of the small-pox matter on the point of a needle and introducing it below the skin. The result was that the disease was communicated to the person inoculated, though generally in a very mild form. This operation seems to have been practised from time immemorial in China and India, and to have slowly travelled westwards till it reached the shores of the Levant and Turkey.

Early in the last century the news of this discovery first reached England ; a description of it was given by several medical men, but at first no attention was paid to it. It was to Lady Mary Wortley Montague that her countrymen were indebted for having

introduced this practice into England. Lady Mary had accompanied her husband to Turkey, where he was ambassador, and she there heard of the process for the first time. Small-pox was a disease which she had good reason to dread ; her only brother had been cut off by it, and she herself had had a severe attack, so much so, that it was thought she would be permanently disfigured. Though this did not happen, the disease left tokens of its passage, for it deprived her of her very fine eyelashes ; a deprivation, it is said, which gave a fierceness to her eyes which impaired their beauty. She watched the Turkish process with peculiar interest, and was so satisfied by what she saw and heard that she had her only son, a child of three years old, inoculated in 1718. The operation was quite successful, and from a letter of Lady Mary to a friend, written shortly before, I may be allowed to make the following quotation :—"I am going to tell you a thing that I am sure will make you wish yourself here. The small-pox, so fatal and so general among us, is here entirely harmless, by the invention of *ingrafting*, which is the term they give it. There is a set of old women, who make it their business to perform the operation every autumn, in the month of September, when the great heat is abated. People send to one another to know if any of their family has a mind to have the small-pox ; they make parties for this purpose, and when they are met (commonly fifteen or sixteen together), the old woman comes with a nut-shell full of the matter of the best sort of small-pox, and asks what veins you please to have opened. She immediately rips open that you offer to her with a large needle (which gives you no more pain than a common scratch), and puts into the vein as much venom as can lie upon the head of her needle, and after binds up the wound with a hollow bit of shell ; and in this manner opens four or five veins. The children or young patients play together all the rest of the day, and are in perfect health to the eighth. Then the fever begins to seize them, and they keep their beds two days, very seldom three. They have very rarely above twenty or thirty pocks in their faces, which never mark ; and in eight days' time they are as well as before their illness. Every year thousands undergo this operation ; and the French Ambassador says, pleasantly,

that they take the small-pox here by way of diversion, as they take the waters in other countries. There is no example of any one that has died in it; and you may believe I am very well satisfied of the safety of the experiment, since I intend to try it on my dear little son."

Lady Mary returned home in 1721, and her daughter was the first person ever inoculated in England. In the course of the following year the Princess of Wales had her two daughters, the Princesses Amelia and Caroline, inoculated, after the process had been successfully tried upon six condemned criminals in Newgate. There was a special reason for the anxiety of the Royal Family with regard to small-pox. Queen Mary, wife of William the Third, died in 1694 of malignant small-pox at the age of thirty-two, to the intense grief of her husband, and the profound sorrow of the nation. In 1721, George the First had recently come to the throne, and the direct succession of the Hanoverian line was of the utmost importance to the Court and to the nation. Queen Mary's death had made a deep impression, which had not subsided after the lapse of five-and-twenty years. Inoculation, introduced into England under such favourable auspices, gradually spread, and was doubtless the means of saving many lives.

We are not, however, to suppose that the new system was allowed to spread unopposed. Far from it; it was denounced as dangerous, precarious, immoral, and irreligious. It was said to be acting in opposition to Providence, by attempting to take the progress of events out of higher hands. It was declared to be unprotestant, because it had come from Turkey. Though opposed both by the medical profession and by the clergy, it was among the latter that its bitterest opponents were found. The Rev. Mr Massey preached a sermon against it in St Andrews, Holburn, in which, to quote the words of a contemporary writer, having selected his text from the book of Job, he inveighed against the dangerous and sinful practice of inoculation, treated the inoculators with the most unqualified abuse, calling them diabolical sorcerers, hellish poisoners, enemies of mankind, and expressed the hope that they would be distinguished from those of the medical faculty who deserve honour, and not be permitted to

minge with them, as the devil among the sons of God. He considered inoculation to be a very ancient art, and to have first been put in practice upon Job by the devil, who, by some venomous infusion into the body of Job, had raised his blood to such a ferment that it threw out a confluence of inflammatory pimples all over him from head to foot, and that truly he had conveyed it to him by the way of inoculation.

Gradually, however, prejudices were got the better of, and the practice of inoculation became pretty general among the upper and middle classes, with the effect of rendering small-pox much milder among those who were submitted to the operation. Whereas formerly about one in every five cases of small-pox died, the mortality among the inoculated was not greater than one in fifty. How it is that inoculation produces a mild form of small-pox we do not know. You will have observed that the essential peculiarity in regard to it is that the small-pox poison is introduced directly into the blood, instead of entering the system by the lungs or some other channel. Now, as a rule, medicines or poisons act more energetically when introduced directly into the blood than when swallowed, and you may have heard of a new mode of administering active medicines by what is called subcutaneous injection. When this method is employed, a smaller dose is required, and the medicine acts more rapidly ; but in the case of inoculation, the direct introduction of small-pox matter into the blood, contrary to all analogy, diminishes the virulence of the poison. But a great objection to inoculation was soon discovered. It had been hoped that small-pox induced by it would not be infectious, but it was soon found that this was not the case, and consequently the effect was to disseminate small-pox throughout the country more widely than before. Previous to inoculation, epidemics of small-pox only occurred occasionally, the disease almost disappearing in the intervals ; but now every inoculated person became a new centre of contagion, and those who were not inoculated were actually in greater danger than before. The process of inoculation could never have become general, and it appears from evidence laid before Parliament, that though it was a great protection to those on whom it was per-

formed, it was a great source of danger to others, so that on the whole the total mortality had been rather increased than diminished by it. It appears that just before the introduction of vaccination, when inoculation was as general as it was ever likely to become, the annual mortality from small-pox in the United Kingdom was 36,000. Accordingly, in the year 1840, inoculation was made illegal by Act of Parliament.

We now come to vaccination, the discovery of which will for ever be associated with the name of Edward Jenner. Jenner was born in the vicarage of Berkeley in Gloucestershire, on the 17th of May 1749. The little town of Berkeley, in the centre of the vale of the same name, is situated near the Severn, in one of the richest pastoral districts of England, which produces the well-known double Gloucester cheese. Jenner was educated in his native village, and in due time was apprenticed to a surgeon in Bristol. He appears to have been of an inquiring disposition, and to have early shown a predilection for Natural History. In this great dairy district it was a matter of frequent observation that those engaged in milking were occasionally subject to sores on their hands similar to those which were found upon the udders of the cows. There was also a popular superstition, for it cannot be called anything more, that those who suffered from this eruption thereby obtained a protection against small-pox, at that time the most fatal and the most dreaded of diseases, but no attempt had been made to investigate the matter any farther. While still an apprentice Jenner had heard of this popular opinion, and it seems at once to have made an impression upon him. At this time, however, he had no opportunity for prosecuting his inquiries, and when, after a residence in London, he returned and settled in his native place, he found that there were great difficulties in the way of his investigations. He persevered, however, and about thirty years afterwards his inquiries resulted in the full establishment of vaccination. Now this was no accidental discovery. Others had heard the opinion of the milkers but had paid no attention to it; Jenner himself had mentioned it to some of his friends, among whom he ranked several of the most distinguished men of his day, but they

seem to have at first looked upon him as an amiable enthusiast. It must be remembered that there were very serious difficulties to be overcome. Jenner soon found that the cows were often free from disease, and it was then impossible to make any experiments; he then found that the cows were subject to several eruptions which were communicable to the milkers, but that only one of these afforded a protection against small-pox; he next discovered that when the true disease was present the matter required to be taken from the pustule at a particular period; and finally, he made the brilliant discovery that it was not necessary that the protecting material should be taken directly from the cow, but that it could, without impairment of its virtue, be passed on from one human being to another. Most discoveries have had, or are believed to have had, in them something of the romance of accident. Newton is said to have been led to his grand discovery by seeing an apple fall from a tree, while he sat meditating in his garden; Watt is supposed to have first had his attention directed to the expansive power of steam, by noticing on a winter evening the lid of a tea-kettle raised by the vapour of the boiling water. It would be as unjust to say that the discovery of gravitation or of the steam-engine was accidental, as to deny to Jenner the full merit of having worked out his great discovery of vaccination in a thoroughly scientific manner.

In June 1798 Jenner's researches were made public, and from that time we may date the establishment of vaccination.

It was not to be expected or even desired that the announcement of a discovery which bade fair to revolutionise a whole department of medicine, should be received without opposition. We have seen that in the case of inoculation the clergy were its bitterest opponents, but on the introduction of vaccination its warmest enemies were members of the medical profession. We know what a powerful motive self-interest is, and on the announcement of vaccination it was not surprising if the self-interest of the medical profession took alarm. In those days small-pox was no inconsiderable source of revenue to the Faculty, not only to the physician but to the surgeon; for while the former claimed the treatment of small-pox as being an internal

disease, on the latter the duty of inoculation, and not unfrequently the subsequent management of the case, devolved; and when the craft by which we have our wealth is in danger, all are ready to cry out with the silversmiths of old, "Great is Diana of the Ephesians." On the whole, however, the reception which vaccination met with is, I consider, very creditable to the medical profession; a few at first bitterly opposed it, but the great mass of practitioners, as soon as they were satisfied of its value, became its warm supporters.

As I have quoted some of the arguments of the clergy against inoculation, it is only fair that I should give you some specimens of what was said by medical practitioners in opposition to vaccination. The argument upon which most weight was at first laid was, that vaccination being derived from the cow, introduced into the human system new and bestial diseases. Thus it was gravely maintained that diseases previously confined to the bovine race had been communicated by means of vaccination. It was asserted that cow-pox, mange evil, abscess, blotches, beastly ulcers, and other diseases of brute beasts, had been incorporated with the human constitution. These statements were not confined to vague generalities, numerous specific instances were appealed to. Everybody might have heard of William Ince, who, it was asserted, had become since his vaccination covered with patches of hair like a cow. There was a little girl, Polly Ringrose, who, poor thing, was not only becoming hairy all over, but coughed like a cow, and squinted as only cows squint. There was Miss Mary Ann Lewis, the cow-poxed, cow-manged young lady, and Master Jowles, the cow-poxed, ox-faced boy. Above all there was an unfortunate child at Peckham, whose naturally fine disposition had become brutal, who went about upon all fours, bellowing like a cow, and butting with his head like a bull.

Such assertions in the present day seem simply ridiculous, but they had their weight at the time, and had no doubt some effect in retarding the early progress of vaccination. I have no doubt that the objections still brought forward against vaccination, will at no distant date be considered as frivolous

as these. It is a remarkable fact that the opposition to vaccination was more violent in England, where it was discovered, than in any other country. No doubt this was owing to the political freedom of Great Britain, which permits empiricism and many species of imposture to flourish, which are either restrained or suppressed by the more rigid laws of other states. Perhaps, as Dr Moore, one of the historians of vaccination, observes, "the facility for controlling such evils and of punishing knaves is some compensation for the loss of the blessing of liberty."

What the precise relation is which vaccine matter bears to small-pox, we do not altogether know. We know that the cow is subject to a local eruptive disease, which when introduced into man constitutes vaccinia, and is protective against small-pox; and we know that the inoculation of human small-pox lymph into cows produces vaccinia, but that human small-pox and cow-pox are identical, though highly probable, cannot be said to be altogether proved. This much, however, is certain, that the two are closely allied, and the practical point is that by vaccination we substitute a mild and local for a virulent constitutional disorder.

In spite of all that has been said by its opponents, no unprejudiced person can doubt as to the efficacy and value of vaccination. In countries where it has been introduced and systematically carried out, the number, the intensity, and the extent of small-pox epidemics have been remarkably diminished, and in a manner which makes the idea of mere coincidence utterly inadmissible. One fact is a sufficient illustration of this. In London alone, during the eighteenth century, the annual mortality from small-pox was from 3000 to 4000. In the ten years 1845 to 1854, when the population was enormously increased, the average annual mortality was about 340, and if vaccination had always been properly attended to, it would have been even smaller. At its first introduction, when the fear of small-pox was strong, vaccination was very generally taken advantage of, but as the pestilence was kept in check persons became indifferent, and the protective means was often neglected. I may mention that it was not til

1853 that vaccination was made compulsory in England, and not till 1864 that this provision was extended to Scotland. By the law as it now stands, every parent must have his child vaccinated within six calendar months of its birth, and the vaccination must be repeated until successful, unless the child be found to be insusceptible. Another circumstance which proves the protective power of vaccination is that where the vaccination of adults, as in the Prussian army, has been regularly performed, epidemics of small-pox no longer occur. The trial of re-vaccination in that army has conclusively demonstrated the efficacy of the measure, to test which we have merely to compare the immunity of soldiers during epidemics of small-pox with the mortality in classes of the same general age in the civil community, among whom re-vaccination is not systematically carried out.

Another advantage obtained from vaccination is, that it not only saves many lives, but that it prevents much weakness, suffering, and deformity. Small-pox is not only directly dangerous to life, it is very apt to be followed by troublesome consequences or sequelæ. Of persons who suffered from the natural small-pox a considerable number remained permanently debilitated, never regaining their former strength. If any scrofulous or consumptive tendency existed, it was very likely to be called into activity. Another risk was permanent loss of sight or of hearing, particularly of the former. Inflammation in small-pox very often attacks the eyes, and permanent blindness is frequently the result. Few children are born blind; in the great majority of cases blindness is due to the destruction of the eyes by inflammation in early life. Before the introduction of vaccination the great proportion of the blind had lost their sight in infancy in consequence of small-pox. It was calculated in the last century that three-fourths of the cases of blindness in blind asylums were due to small-pox. From this danger effectual vaccination is an almost absolute protection. Finally, small-pox was formerly very much dreaded, in consequence of the permanent marking which a severe attack of the disease left behind it. Unfortunately, such cases are still occasionally met with; but in the days of our great-grandfathers there were comparatively few families in which some

pretty face had not been made plain, some fine complexion destroyed.

Lady Mary Wortley Montague, to whom I have already referred, was not only a very beautiful, but a very clever woman. During the course of her life she wrote a good many poems which have since been collected, and have had a tolerably wide circulation. Among these is one entitled "The Small-pox," in which a lady, who is convalescent from that disease, describes her feelings on looking into her glass for the first time. From this I may be allowed to quote a few lines :—

"The wretched Flavia, on her couch reclin'd,
Thus breath'd the anguish of a wounded mind,
A glass revers'd in her right hand she bore,
For now she shunn'd the face she sought before.
'How am I chang'd ! alas ! how am I grown
A frightful spectre to myself unknown !
Where's my complexion ? where my radiant bloom,
That promis'd happiness for years to come ?
Then with what pleasure I this face survey'd !
To look once more my visits oft delay'd !
Charm'd with the view, a fresher red would rise,
And a new life shot sparkling from my eyes !
'Ah ! faithless glass, my wonted bloom restore ;
Alas ! I rave, that bloom is now no more !
The greatest good the gods on men bestow,
Ev'n youth itself to me is useless now.

Ye cruel chemists, what withheld your aid ?
Could no pomatum save a trembling maid ?
How false and trifling is that art ye boast !
No art can give me back my beauty lost.

Galen, the grave, officious squirt was there,
With fruitless grief and unavailing care ;
Machaon too, the great Machaon, known
By his red cloak, and his superior frown ;
And why, he cried, this grief and this despair ?
You shall again be well, again be fair ;
Believe my oath (with that an oath he swore) ;
False was his oath ; my beauty was no more !

Adieu ! ye parks—in some obscure recess,
Where gentle streams will weep at my distress,
Where no false friend will in my grief take part,
And mourn my ruin with a joyful heart ;
There let me live in some deserted place,
There hide in shades this lost inglorious face.
Plays, operas, circles, I no more must view !
My toilette, patches, all the world adieu ! ”

The last benefit conferred by vaccination is that it gives us the means of getting rid of small-pox altogether. Small-pox, as I have already said, differs from most diseases in this, that it is only propagated by contagion ; it never, so far as we know, arises anew. Various fevers and other diseases are produced by overcrowding, bad drainage, and other general causes, but small-pox never seems to be produced in this way. All we know of its history shows that it has always been imported. It came to us from the East, and we can trace its importation into America in 1527, about thirty-five years after its discovery. It was unknown in Australia and New Zealand for many years after their discovery, and is said to have been imported into the former country by the steamship the *Great Britain*. Now if every one were protected by efficient vaccination small-pox could no longer spread, as no one would be susceptible of the poison, and thus the disease might in course of time be literally stamped out.

In spite of the incalculable benefits which have been conferred by vaccination, there is still a certain number of persons who oppose it on various grounds, and Anti-Vaccination Societies have been established with a view to influencing the legislature to cease to render vaccination compulsory. As this lecture is not intended to be of a controversial character, I shall refer to the objections in the briefest possible manner.

The grounds on which vaccination is opposed are various. In the first place, it is said to be unnatural, and even irreligious, to introduce a disease into the system with the object of protecting it from a malady to which it may never be exposed. The answer is simple : before the introduction of vaccination small-

pox was almost always more or less epidemic ; and as we have seen, the most exalted rank afforded no immunity from its attacks ; and were vaccination discontinued this state of matters would soon be restored. As to being unnatural : our life is now so artificial that it is difficult to say what we do that *is* natural. It is unnatural to wear clothes, to cook our food, or to avail ourselves of the services of the lower animals for purposes of transport or locomotion ; but are not these unnatural actions the very proofs of advancing civilization ? There is in man an irresistible impulse to rise above the condition of the savage ; and it is this very instinct which distinguishes him from the beasts of the field. There is, however, such a spirit of contradiction inherent in some minds, that there is probably no discovery which has not been objected to on the ground that it is unnatural or injurious. I suppose there are few who will deny that a certain amount of good has been done by the medical profession ; yet there is a class of the community who style themselves, I believe, the peculiar people, one of whose tenets is that it is morally wrong to apply for medical assistance, and that the treatment of disease should consist exclusively in prayer, anointing with oil, and laying on of hands. I remember very well when chloroform was first introduced, that it was strongly objected to on the ground that it was wrong to abolish pain, that in surgical operations pain was beneficial, and that to prevent it would be hazardous to the patient. I wonder if any of these objectors ever showed his sincerity by declining on these grounds to take chloroform when he was having a tooth extracted, or a whitlow opened.

Another argument brought forward against vaccination is that it is dangerous, that it is the cause of skin diseases, and that in many cases it is even the direct cause of death. Scrofula and consumption are cited as amongst the chief diseases which may be directly transmitted to healthy children by means of vaccine lymph. If, however, due caution be used in vaccinating, if the operation be not performed upon too young, feeble, or sickly children, not during the time of teething, nor at very unfavourable seasons, the bad results will be found to be so extremely

rare, that in comparison with the advantages attained, they will appear of trivial importance. Of course when I speak of vaccination, I suppose it to have been carried out in the best manner, for there can be no doubt that bad results may follow when the operation has been carelessly performed. This leads me to say a few words regarding the precautions to be attended to in the performing of vaccination. Of course I do not enter into particulars which concern the operator ; I only make one or two general suggestions.

In the first place, except in very pressing cases, children should only be vaccinated when they are in good health. The existence of any acute or chronic disease, or particularly of any skin affection, will almost certainly interfere with the course of vaccination. No doubt there are circumstances, as when small-pox is epidemic, which may render it imperative to perform the operation, notwithstanding the existence of contra-indications.

In the next place, the child should be vaccinated in early infancy. One-fourth of the total mortality in England from small-pox occurs in children under the age of one year ; and hence the great risk of delay. Healthy children living in large towns should be vaccinated when about three months old ; in more delicate children it may be postponed for a month or two ; but all, except those whose health positively contra-indicates it, should be vaccinated before the age of six months. Finally, the lymph used in vaccinating should be taken from healthy children, from healthy vesicles, and a sufficient number of punctures should be made. As, however, these are points with which every vaccinator is supposed to be familiar, I need not farther insist upon them. I may mention, however, that the various Licensing Bodies now require that every one of their licentiates shall have received special instruction in the performance of vaccination, and shall have obtained a certificate of his competence to perform it.

The last point I have to consider is the protective power of vaccination. It may be stated generally that persons who have once been successfully vaccinated are, as a rule, permanently protected against small-pox. A certain proportion will, however, be liable at some period of their lives to take the disease a second

time, generally in a mild and modified form, though occasionally severe and even fatal cases occur. You are aware that one attack of scarlet fever, measles, or hooping-cough usually protects from a recurrence of these diseases. Exceptions, however, do occur, and every now and then we have instances of second, or very rarely of third, attacks of these diseases. Now vaccination, with its subsequent phenomena, may be looked upon as a very mild attack of small-pox; and it is not surprising that after a certain period the protective influence should sometimes wear out, and susceptibility return, though usually in a very trifling degree. An attack of natural small-pox usually, but not invariably, protects against a recurrence. I remember, when I had charge of the Small-pox Hospital, having a patient with a severe form of the disease, where the pocks of the second attack were actually situated on the pits of the first. As such exceptional cases occur after the natural disease, they occur with still greater frequency after vaccination; and hence arises the question of the propriety of re-vaccination. By many this practice is only considered necessary when there has been some defect in the primary vaccination, as indicated by the imperfect character of the scar or cicatrix; but there can be no doubt that it is very valuable, by extinguishing the renewed susceptibility to small-pox which may gradually arise. I believe it, therefore, to be a very proper precaution that every one should be re-vaccinated between fourteen and sixteen years of age. In a great many it does not "take," as it is called, and this merely indicates that the susceptibility to the disease has not returned; while in a considerable proportion it takes as perfectly, or nearly as perfectly, as in the infant. When re-vaccination has succeeded, it is, I believe, quite unnecessary to repeat it; but if it have not, it may be performed again a few years later, particularly if an epidemic of small-pox has broken out, or if the individual should be about to proceed to a warm climate, which appears to have the effect of increasing the susceptibility.

Were vaccination and re-vaccination properly attended to, small-pox might, as I have already said, be stamped out; but although this very desirable consummation is theoretically possible, I am afraid it will never be arrived at practically. Prejudice, ignorance, and indifference are too formidable enemies to be ever

entirely got the better of, and we must, I fear, be satisfied if we confine the ravages of the disease within the narrowest possible limits

Before concluding, I may be permitted to make a few observations as to what may, in the future, be expected of medicine in the prevention of disease, more particularly of these epidemic diseases which contribute so largely to the annual mortality. Till lately it was considered that the sole duty of the physician was to cure disease, but very erroneous ideas were entertained as to what disease really was. Diseases were formerly looked upon as new and independent entities, but now we look upon them as perversions of natural or physiological processes. Formerly, when an inflammation manifested itself, it was regarded as something superimposed upon the organism ; as an enemy attacking the fortress of life, which required to be repulsed by the most energetic measures. Its supplies must be cut off by the enforcement of a rigorous diet, and it must be attacked with the heavy artillery of bleeding, mercury, and blisters. But it was not kept in mind that by these measures the garrison was weakened in an equal degree with the enemy, or rather in a greater degree, so that even if the adversary were overcome or retired from the contest, the patient often succumbed owing rather to the severity of the treatment than to the malignancy of the disease. Now, however, we look upon inflammation and other diseases in a different light ; we view them as perversions of normal states, induced by the operation of some external or internal agency. We endeavour, therefore, to put the part or the system in the most favourable circumstances for the resumption of its physiological condition. By the adoption of this rational treatment, a very considerable diminution in the mortality of disease has taken place.

But of late years it has been recognised that the physician has another duty to perform. It is not enough that he interferes when disease has manifested itself ; he is called upon to show how it may be prevented from occurring. And it must be borne in mind that this preventive office is even more important than the curative. Disease, when fairly established, is often incurable ; or, if the more urgent symptoms are removed, it frequently

leaves behind it a permanent weakness or debility. As there is never a battle in which the conquerors do not suffer more or less severely, there is never an attack of illness which does not leave the body weaker than it found it. It is only lately that the fulfilment of the duty of preventing disease has become partially possible, because it is only lately that any definite knowledge has been obtained regarding the causes of these diseases. Within my own recollection two of the most important fevers, typhus, and typhoid or enteric fever, were confounded together, and of course their causes were unknown. I do not say that even now their causes are thoroughly understood, for there is still a difference of opinion as to whether or not they should be included among the specific diseases. It is, however, now well ascertained that whereas typhus fever is caused by, or at least is closely associated with destitution and the crowding together of human beings, typhoid fever is due to bad drainage and the emanations from decaying excrementitious matter. The physician has proved this, and so far has performed his part; it remains for the sanitary authorities to carry out his suggestions, and to banish these diseases from our midst. Considerable improvements have been effected, so far as typhus is concerned, by piercing new streets through densely populated localities, and by preventing overcrowding in dwelling-houses, but in the case of typhoid fever we cannot say even this. There can be no doubt that bad drainage is worse than no drainage at all, and, unfortunately, our drainage and other sanitary appliances are often defective, both in their design and in their execution. We constantly hear of typhoid fever appearing among the inhabitants of new houses; now this is absolutely unpardonable, as showing that the drainage arrangements have been badly planned, or that their execution has been carelessly carried out. And this state of things will continue until the authorities insist that a strict supervision be exercised on the construction of all new tenements, and that when constructed this supervision be renewed from time to time.

With regard to the more strictly specific diseases, I have, I trust, shown you how vaccination has robbed small-pox of its terrors, and there is strong reason to hope that the same result may be arrived at in the case of measles and scarlet fever. The

poison of these diseases, as in the case of small-pox, doubtless consists of infinitely minute bodies, which float about in the air, and which, when introduced into the bodies of unprotected individuals, lead to the development of these diseases. Now it is in the highest degree probable that we may succeed in rendering these poisons practically innocuous. We are led to believe this by knowing what has already been done in the case of a disease which bears a close analogy to them. There is a very deadly malady to which some of the lower animals are subject, called splenic fever. It has been known for some time that in the blood of animals dying of this disease there are very minute foreign bodies of a vegetable nature which have the power of almost indefinite multiplication. It was then shown that these bodies could be cultivated in fluids outside the body, and that they formed germs which could remain long inactive, but which, under suitable conditions, could grow and multiply. Then followed the brilliant discovery that by cultivation this fungus could be so modified that when inoculated into animals it only produced a mild attack of the disease, but that this protected the animals from subsequent attacks, even when exposed to the poison in its most malignant forms. There can, I think, be little doubt that by means of experiment it will yet be shown that the poison of measles and scarlet fever may be modified in a similar manner, and that, as in the case of small-pox, these diseases may be deprived of the greater part of their malignancy.

In bringing this lecture to a conclusion, I have only a single remark to make. Of late years the advances of medicine have been very rapid in every one of its departments, and everything leads us to believe that they will be still more rapid in the future. We can never expect to get rid of disease altogether, for susceptibility to disease is a law of our nature. It cannot be expected that medicine shall ever take rank with the exact sciences, for where we have to deal with the phenomena of life, vitality introduces a disturbing element, which we can never expect to get the better of; but we may safely look forward to a period when we shall be enabled to undertake a more equal struggle with disease, — a period when the success of the physician shall be more nearly than at present on a level with his good intentions.

A COLD:

What it means ; its possible consequences ; and how it is to be avoided.

BY JAMES O. AFFLECK, M.D.

MR CHAIRMAN, LADIES, AND GENTLEMEN,—The subject of this evening's lecture was suggested to me by the Committee of the Health Society, and, although left free to make choice of other subjects, I did not feel disposed to depart from their selection, seeing that the topic is one of general concern and much practical importance. It had, besides, this additional recommendation to me, namely, that the manner of handling it was indicated in the terms stated on the programme. I have accordingly undertaken to address you on the subject of A Cold ; what it means ; its possible consequences ; and how it is to be avoided.

Instead of attempting at the outset to define precisely the common expression "a cold," of which most of us already possess some notion derived from personal experience, I shall at once proceed to consider the first part of the subject, viz., WHAT A COLD MEANS, and this will, of course, involve in a general way its definition.

Among the many ideas which we are wont to associate with life, and which vary in accordance with our moods or currents of thought at particular times, whereby we liken it to a journey, a race, a conflict, a dream, &c., there are few more appropriate, or more constantly applicable, than that which views it as a condition of defence or resistance. In point of fact, however, this view is something more than a mere idea, it is an actual attribute of life. It could be easily shewn to be true of life in its social, intellectual, and moral aspects, but it concerns us here to deal

with life in its physical manifestations ; and whether we regard these as displayed in plants or in animals, we shall find that there are always in operation processes, which, while serving many other ends, such as growth and nutrition, at the same time effectually secure the organism from the action of hurtful influences, that would, if left to exercise their effects unresisted, infallibly accomplish its destruction. While this general principle is equally true in the case of man, it is to be observed that the conditions of his existence are affected by civilization and by his surroundings, and therefore, that besides these natural processes of defence, he must have recourse to his intelligence to devise additional means for his protection. And yet we know that, notwithstanding all that can be done in this way, the enemy gains but too ready access to him, and works havoc in his frame, nay, that even many things calculated to minister to his comfort and well being, become under certain circumstances the means of his hurt or even of his ruin. Among the agencies of this kind which may be productive of good or of evil, there are few of such consequence as the atmosphere in which man lives and breathes. Who does not feel how much of health and comfort depends on the state of that element ? Its purity is essential to respiration, and on its condition as to temperature hang important issues of life. Now it is with the relation of our bodies to the temperature of the atmosphere, and with its influence upon them, that we have at this time specially to do ; but before we proceed further in the discussion of this subject, we must consider for a little in what way our physical frames are acted on by the coldness or warmth of the surrounding air. This again will render necessary my making, in the first place, some general remarks upon the subject of the sources of that animal heat which all of us who are in health feel we possess. This heat, then, is derived not from without, but from within our bodies, where it is generated as one of the results of changes which are constantly going on in the processes of nutrition—in the wasting and building up again of our tissues. Every organ or member of the body in the performance of its function expends part of its substance—it wastes—but if the body be in health, and due nutriment supplied, this is immedi-

ately repaired ; and in this process, which is very much a process of combustion, heat to a greater or less amount is generated. This statement is true in an especial manner of our muscular system, the part of our structure which is most universally and constantly in a state of activity. Thus the generation of heat is one of the necessary properties and accompaniments of animal life—inseparable from it ; and when life ceases the animal heat departs and cannot be revived. You cannot warm a dead body any more than you can reanimate it.

But the heat thus generated does not in health accumulate within us,* but is always being given off from our bodies in various ways. Thus part of it is given off by the lungs, for the air we breathe out is warmed by it ; part of it is given off by the skin, from which it radiates into the surrounding atmosphere, or is conducted away by cooler bodies, or is given out in the form of perspiration. Besides this, others of the natural channels of the body carry away a certain amount. It is thus evident that in the living body there is a manufacture and an expenditure of heat constantly going on. Notwithstanding this the heat of our bodies in health is a tolerably uniform quantity (98° — 99° F.) whatever be the temperature of the surrounding atmosphere, and any material deviation from this betokens some departure from health. It might interest you to hear of the extremes of temperature which the human body can bear with impunity. As regards cold, the experience of Arctic voyagers is remarkable. Thus Capt. Sir John Franklin recorded a cold of -58 or 90° below freezing point ; Capt. Back, -70 or 102° below freezing point ; and more recently Capt. Sir George Nares, in his interesting account of his voyage to the Polar Seas, describes his experience, in March 1876, of the extraordinary temperature of $73\cdot75$ or more than 105° below freezing point. It is difficult for us, even with the experience of our most severe winters, to conceive of this amount of cold. Capt. Nares states that the very “whisky froze hard, and a few of us had the rare opportunity of eating it in a solid state.” The

* It has been estimated that if this heat were allowed to accumulate within us, and none to be given off, it would be sufficient to raise the body to the boiling point in thirty-six hours.

health of the crews kept good even in this terrible cold. "Fortunately," adds Capt. Nares, "these extremely low temperatures never occur with a high wind, or no human being could possibly endure the weather." As regards heat, in many parts of the tropics, there is a daily temperature of considerably over 100° F., but a much greater amount than this can be borne for a limited time without injury. Experiments were made on the subject about a century ago by Drs Fordyce and Blagden, who found they could remain for a considerable time in a chamber heated to 260° , and it is well known that certain workmen, such as those in sculptors' foundries, have to go into chambers where the floor is red hot and the air heated to 300° or 400° . If we bear in mind that in such extremes alike of cold and heat, the temperature of the body remains unaltered to any appreciable extent from its natural standard (98° — 99°) it follows that there must be some defensive power or arrangement possessed by our bodies which enables them to withstand the evil effects we should naturally expect to arise; in short, that there must be some means or adjustment for regulating our bodily temperature and keeping it at a uniform point. And such an arrangement does exist, and is in fact simply that process of the giving off of heat to which I have already referred. We saw that every muscular effort implies an increased waste of tissue, and therefore an increased production of heat. When we exercise our muscles vigorously, such as in active walking movements or manual labour, and thus generate much heat within us, how is it that we get rid of the overplus above the normal amount? Chiefly by the lungs and skin. The very activity makes us breathe faster, and therefore more heat passes away from us in this manner, while at the same time the blood is driven to the surface of the body and circulates in increased amount in the skin, which thus becomes the agency, by the processes of radiation, conduction, and perspiration, of drawing off a very large amount of warmth. In this way the increase and loss of heat are equalised. Again in the case of the action on our bodies of extreme cold the same result is brought about, as we shall afterwards see, by a sort of reverse process. We shall also find that the nervous system is largely concerned in controlling all these

natural operations. Now these statements regarding the heat regulation of our bodies, and the chief factors concerned therein, are of the utmost importance in relation to the subject in hand, for it is by some disturbance in this physiological equilibrium, if I may so express it, that the morbid effects of cold are induced.

Let us then inquire for a moment what are the effects on the body of cold when it is left free to exercise its hurtful action. The tendency of extreme cold is to the depression of all the vital functions, an effect which it exerts apparently through the agency of the nervous system. Death from exposure to cold is happily a comparatively rare occurrence in this country, and yet never a winter passes without some instances of it. In the severe winter of last year the number of deaths from this cause was exceptionally large all over the kingdom. In such cases the sufferer, after prolonged exposure, in which much animal heat is lost, sinks into a lethargic state, in which the functions of respiration and circulation speedily cease, the fatal event being hastened if the person has been long without food, or is in a state of intoxication. The effects of cold on the functions of the nervous system were never more strikingly displayed than among the soldiers of the First Napoleon in the disastrous retreat from Moscow in 1812, when we are told some of them became mad, many were seized with convulsions, others staggered about as if intoxicated, and sank into a stupor from which they could not be aroused.

Short of such extreme results, other evils, essentially the same in nature, though differing in degree and in their subsequent effects, are capable of being produced by cold. These may be either local, or general in the system. As an illustration of the former, there is the condition known as frost-bite, of which the familiar chilblain is but a mild form. Here, some exposed part of the body is subjected to the action of extreme cold; it becomes pale and dead looking, and unless the circulation be quickly restored, does actually perish by a destructive process of inflammation. The cold has altered the normal nutrition of the part, has lowered its vitality, to such an extent as to cause this inflammation to arise in and around it. This may be considered a direct local effect. But apart from this, and far more frequently,

there are other effects which are to be regarded as secondary consequences of the depressing action of the cold on the general system, particularly the nervous system, and which are shown in lowered vitality and subsequent inflammatory action in some part or organ. Let me explain. The nutrition of every portion of the body, to the most minute tissue, is under the direct influence and control of the nervous system, as is proved by the fact that anything which interrupts or interferes with the communication between a part and its nervous connections, will affect the health or soundness of that part. I cannot at present stop to inquire how this nervous influence is exercised, but you may just bear the fact in mind. The nervous system, which, as you know, embraces the brain, spinal cord, sympathetic, &c., and the numberless branches of nerves which ramify everywhere throughout the body, and in no place more abundantly than in the skin, is so arranged that an impression made at one point, and conveyed from thence to the spinal cord or brain, may there excite either the same or else a new set of impressions or actions, which may be conducted to another and far distant point. It is in some respects like the very useful system now in operation of what is called the "telephonic exchange." A number of individuals have telephonic wires leading from their houses or places of business to a common central office. If then A, living in the west end, wishes to communicate with B, living in Leith, he cannot do so directly, but he sends a message to the central office to say, "put me in communication with B," whereupon his wire is switched on to connection with B's wire, and the two can then converse with each other. Now to apply this to the subject in hand, an impression of a depressing kind is made upon some part of the surface of the body, say the feet, the chest, or neck, by cold or damp. It is conveyed to the brain, which sends it off again, not necessarily to the part or organ from whence it came, but to some other one altogether. The message the brain sends is that for the time the healthy nutrition of the part is to be altered or disturbed, and, as a consequence, some mischief, generally in the form of an inflammation, more or less severe, must result. This, I take it, is very much what happens when we catch a cold.

What determines the locality of the body where the effect is to appear is beyond our power to explain. Why, for example, it should happen that of three persons exposed to the same amount of cold, one should take a rheumatic fever, another a simple cold in the head, and the third perhaps be entirely unaffected, we cannot positively say. It may be, however, that in each individual there are certain parts and tissues of the body which, from constitutional causes, inherited or otherwise, or from previous diseased action in them, are more vulnerable than others. We know that there are parts which, from their situation, their functions, or their relations to other organs (such as the relation of the lungs and the kidneys to the skin), are easily excited to inflammatory action, as the result of a chill to the surface of the body.

These points, then, enable us to settle the question what the term "a cold" means. It means, or rather ought to be understood as meaning, an inflammation of some portion of the body brought about by the direct or indirect action of a lowered temperature. Popularly, of course, the term has a more restricted meaning, and is generally used in reference to an irritation of the respiratory passages, or, as it is technically called, a catarrh, about which I have something to say under the second division of my subject.

Meanwhile, having tried to show what the *nature* of the process is, it may be useful to consider for a moment *how we take cold*. It may be stated generally that we take a cold by some cause which makes us part too suddenly and too abundantly with our natural animal heat, in fact by our becoming chilled. While we are in health our bodies may, as we have seen, sustain cold of extreme degrees unhurt, but even then certain conditions are necessary, such as that food be sufficiently supplied, that exercise be taken, and that adequate protection by clothing be afforded—conditions, however, which when observed, not only enable us to bear cold with impunity, but cause it to excite in us that pleasant glow which proves it to be a source of strength and exhilaration.

But let these conditions be wanting, and then the case is totally altered. If our health be depressed from any cause, or if we have had insufficient food, we feel the cold air take hold on us in a way that is the reverse of comfortable. Or again, if we are long

exposed to a low temperature, and are compelled to remain in a state of inaction, we quickly lose our animal heat, and are unable to replace it in adequate measure, and so become more or less thoroughly chilled. Thus it is that we suffer when in cold weather we sit in rooms without fires, or go into places of resort which happen to be imperfectly heated. Our heat is radiated away into the cooler air around, and we readily catch a cold. All the more surely will this take place if our clothing be thin, or of such a kind as offers but a feeble impediment to this heat radiation. Sudden alternations of temperature too, such as in leaving a warm apartment and facing a cold wind, particularly if the body be perspiring, produce a like result, by disturbing the natural heat-equilibrium already described. Further, when cold is accompanied with moisture its chilling effect upon the surface is intensified, and we all know that there is no more certain way of catching a cold than by exposure to a damp atmosphere of low temperature, or by getting wet through. It should ever be borne in mind that the power of resisting cold even in health is much less at the extremes of life than at any other period, and that therefore children and old persons alike part with their animal heat and suffer from the effects of this in a very marked degree.

It is evident, then, that it is in most instances by impressions made upon our skin that we take cold. This wonderful vesture of our bodies is not only, as has already been told you in previous lectures, of prime importance as an organ of elimination of waste matters, but it is equally so as a medium of conduction in relation to the temperature within our systems and that outside of us. It is not a good conductor, and well for us that it is not, otherwise we should be liable to be hurt far oftener and far worse than we are. This comparatively negative power as regards conduction it is that in great measure prevents our suffering from the sudden and frequent changes in the temperature of the air around us, as it no less prevents our losing too quickly or too abundantly the heat within us. But in addition to this, we possess in the function of the skin, if it be in health, an arrangement which may be regarded as constituting our

first line of defence against the hurtful influence of extremes of temperature. No sooner does a cold blast impinge upon us than the skin, richly provided as you already know, with bloodvessels and nerves, contracts, and we often observe the surface roughened with little points in consequence of this contraction. In thus contracting its bloodvessels become emptied of their blood, and its heat-radiating and evaporating function is for the time arrested, while the body goes on accumulating heat sufficient to furnish a reaction when the cold is withdrawn, or before it. This reaction or glow is one of the best indications that we have not been injured by the cold. But this salutary process operates within comparatively narrow limits, and is conditioned by so many circumstances, that it too often proves inoperative. Thus it may happen that the vitality of the skin is weak from natural delicacy, or from neglect to maintain it in a healthy condition, and so it will fail to contract vigorously or remain contracted till a glow can be established in time to prevent mischief, and the same thing will happen even in a healthy skin, if the cold be too severe and too long continued. The result of this will be a too rapid withdrawal of heat from within, and an impression made upon the nervous system which will be transmitted to some part or organ, and produce in it the morbid effect of cold, viz., inflammation. It would seem, however, in such instances that before matters proceed to this extent there is often an effort of nature to keep the enemy, which has now got within the lines, from advancing to the citadel. What, for example, causes us to shiver when we leave our homes and go out into the cold air of a winter night, or what is the meaning of our sneezing vigorously when exposed to a cold draught? It would seem probable that these acts stimulate the depressed nervous system to increased resisting power, and in this way tend to ward off the full effect of the action of cold. Moreover they in a peremptory way call our attention to the matter, and lead us to join the efforts of our will in keeping off the enemy. The statement that "the man who resolves not to take a cold seldom does,"* although it may seem to you a strong one has nevertheless much

* *Lancet*, 29th November 1879.

truth in it, for not only does he brace himself up to exert a strong mental resistance when he feels himself threatened, but he almost instinctively resorts to some physical means to prevent his being chilled, and to bring himself aglow, such as by quickening his pace, or other vigorous and steady movement, and in this, if he be in health, he will generally succeed. Some of you may remember the graphic description by Cowper in the "Task" of the country labourer driving home his team in a stormy winter evening:—

"He, formed to bear
The pelting brunt of the tempestuous night,
With half shut eyes, and puckered cheeks, and teeth
Presented bare against the storm, plods on.

* * * *

O happy ! and in my account, denied
That sensibility of pain with which
Refinement is endued, thrice happy thou !
Thy frame, robust and hardy, feels indeed
The piercing cold, but feels it unimpaired.
The learn'd finger never need explore
Thy vig'rous pulse ; and the unhealthful east
That breathes the spleen, and searches every bone
Of the infirm, is wholesome air to thee."

Unhappily, however, we are not all made of such stout material, and in our modern ways of living any of us—even the strongest—may catch a cold, whether we resolve or no. Indeed it would seem that many of our colds come upon us by stealth, and we are often unable to say how we have contracted them. I must now, however, leave this the first part of our subject, but before doing so let me in a word summarise the points I desire you to bear in mind respecting the nature of a cold.

1. That our bodily heat depends not on clothing nor on anything external to us, but upon active changes going on within us in the processes of nutrition.

2. That during life this heat-generation is always going on, while at the same time there is a giving off of heat from our bodies, chiefly by the lungs and skin, and that the due adjustment of this heat-production and heat-discharge maintains the

body at its normal standard of temperature, 98°—99° F., irrespective of that of the surrounding air.

3. That extreme cold by removing our bodily heat tends to exercise a depressing effect upon our nervous system, but that in health this effect is resisted up to a certain point by the protection afforded by clothing, but more especially by the defensive and reacting power of our skin.

4. That when this defence is broken down, either by too prolonged exposure, ill health, want of food, insufficient clothing, &c., a morbid impression is made upon our nerves and brain, which is conveyed from thence to some part or organ of the body, and produces an alteration in its nutrition, which finds expression in the form of inflammation either slight, as in the case of a simple catarrh, or of more grave and serious character; and that all this is included in the term "a cold."

II. We have now to consider the second part of our subject, viz., THE POSSIBLE CONSEQUENCES OF A COLD. It will, I think, be obvious even to those possessing no medical knowledge at all, that this expression cannot be taken in a literal sense, for in disease, as in everything else, the contemplation of possibilities might exercise our minds for a whole lifetime. I must therefore limit myself to a reference to the chief possible consequences of the taking of a cold as these are ordinarily presented to medical experience, and even this restricted view will not, in the time at our disposal, admit of anything beyond the most general remark.

It may be said with truth that there is no disease to which the human body is liable that may not be seriously influenced by the effects of cold, but while this is true it is also the case that certain ailments are affected in a very special manner by this cause, while many others undoubtedly owe their origin to it. The catching of a cold will not indeed bring on any of the specific fevers such as scarlet, typhus, or typhoid, or the other so called "zymotic" or infectious maladies, each of which is primarily due to the reception into the system of a particular disease-poison or germ. But while this is the case it is no less true that the taking of a cold exercises a very important influence in relation to this class of ailments. Thus it will by its depressing action render

us more liable to receive the contagion of them if we are thrown in the way of it. But this influence of cold is shown chiefly by the extent to which it aggravates the severity, and increases the mortality, of almost all those complaints I have mentioned, by inducing complications and results which are often far more serious than the original disease. This is strikingly the case as regards the infectious diseases of childhood, such as measles, hooping cough, and scarlet fever. Simple enough ailments in themselves in the vast majority of cases, they become, chiefly by reason of their complications (which are principally inflammatory affections of the lungs or kidneys), the causes of a terrible destruction of infant life, and are justly looked upon as the scourges of our families. These complications no doubt belong to, or form part of, the disease, and may appear despite the greatest care; but it is unquestionable that in a large proportion of instances they are justly to be ascribed to the influence of cold, the tables of mortality of the Registrar-General showing how largely the death-rate from these diseases is increased in the colder months of the year, or when the temperature is low. I may be allowed to add my own confirmation of this, as the result of observations in the Fever Wards of the Royal Infirmary for a number of years past. But the evil is not to be measured alone by the extent of the mortality, for such complications, even if recovered from, but too often lay the foundation for future bad health, and careful medical enquiry can often trace back some disease occurring in later life to its origin in connection with one of the disorders of childhood. This is a fact which parents and those in charge of children would do well to ponder, and the practical lesson it conveys as to the exercise of the utmost care and watchfulness needs no enforcing.

Rheumatism is another malady upon which the influence of cold is exhibited in a marked degree. Doubtless a rheumatic constitution is in many persons an unfortunate inheritance, but whether connected with this or not, the acute form of the disease, that which goes by the name of rheumatic fever, is in almost all instances traceable to a chill of the surface of the body produced by getting wet through, by long exposure to a cold wind, or by

sudden arrest by cold of perspiration. This painful complaint is a common ailment of early life, particularly in our climate, and is ever to be looked upon as a serious one, not so much from any immediate danger (though even that is not inconsiderable) as from its tendency to induce disease of the heart. Every physician knows how large is the number of cases of heart disease that owe their origin to acute rheumatism in youth, brought on as the result of a cold, and it is sad to reflect how much suffering and death are thus due to causes in great measure preventible. But not alone in its relation to heart disease is the evil effect of rheumatisms made evident. The disease once occurring tends to return, and to bring about alterations in the joints which render many a strong man stiff and infirm long before his time, to say nothing of aches and pains which afflict him on every change in the weather, and add so seriously to the burden of life.

On no part of the human body does cold tell with more severe and deadly effect than upon the organs of respiration. The deaths in this country from diseases affecting these organs far outnumber those from any other class of ailments.* The respiratory tract commences at the nostrils, extends back into the throat, down into the windpipe, then into the bronchial tubes, which lead into the lungs, which latter organs are invested by a thin delicate membrane called the pleura. The inner passage, that is from the nostrils to the lungs, is lined throughout with a thin membrane called the mucous membrane. It is easily excited to inflammation, and is the part which suffers most when we take a cold in the head or chest. It is not, however, by breathing in cold air,

* This in Scotland in the year 1877 (according to the most recent annual report of the Registrar-General), out of the total number of deaths, viz., - - - - - 73,937

The deaths from diseases of the respiratory organs (chiefly bronchitis and inflammation of the lungs) numbered	-	-	-	14,249
And from consumption alone	-	-	-	8,342

22,591

Or 1 out of about 3·3 deaths is due to diseases affecting the respiratory organs

over this membrane if it be in a healthy state, that we catch a cold, but in the way I have already tried to explain, by a chill to the surface of the skin making an impression on its nerves, which is conveyed to the brain, and from thence reflected back upon, or telephoned to, some other part. Now it appears to be this very part that is in most frequent telephonic communication with the brain upon the subject of a cold, partly no doubt from its exposure to vicissitudes of temperature rendering it more susceptible, but no doubt also from its intimate physiological relationship to the skin.

Let us look for a moment at the effects of a cold on the various parts of this respiratory tract, bearing in mind that usually only a portion of it is affected at one time, although it may spread on to another part. The effect is, as I have already stated, to produce an inflammation of the mucous membrane, which causes at first swelling and then some discharge from the surface, both of which will impede more or less the free passage of air into and out of the lungs, and affect the breathing according to the part of the tract where the disease is located. Thus when it is confined to the first part, viz., the nose, we experience those symptoms characterising a cold in the head, with which we are all familiar, and which, though very unpleasant, particularly on lying down, does not seriously interfere with breathing, since we have in the mouth a supplementary channel for the entrance and exit of our breath. But let us pass a little further on, say into the windpipe, and here the effect of a cold is a very much more serious affair. At this part the channel for the passage of air is very narrow, and there is no supplementary one, so that when it becomes narrower by swelling, or inflammatory deposits on its surface, a formidable mechanical impediment is presented to the breathing, and there is risk of suffocation. This is the state of things in croup, and constitutes the danger of this malady. Let us now inquire how a cold affects the branches of this windpipe, or the bronchial tubes as they are called, the channels leading directly into the lungs. You will notice that these tubes differ in size, being larger as they pass off from the trunk, *i.e.*, the windpipe, and smaller as they branch away towards the lungs, the ultimate ones being exceed-

ingly minute, and ending in the air cells of the lungs, where they convey the pure air breathed in to the blood, which requires this for carrying on the functions of life. Well, when inflammation attacks these bronchial tubes there is produced that common disease (one of the most common) bronchitis. This is one of the most serious of complaints, and its gravity depends on the extent to which the inflammation spreads throughout this bronchial tree, whether both sides are affected, and whether it involves the larger or the smaller branches. There is always more or less obstruction to breathing in bronchitis, as well as cough and expectoration, and general illness; but more particularly is this the case when the disease is located in the smaller branches. This is the form it is apt to assume in young children, and a very fatal form it is. Thus in Scotland in 1877, of the total number of deaths from bronchitis, viz., 9182, no fewer than 4305 occurred in children under three years of age. It is also extremely fatal to old persons. But apart from its fatal effects, bronchitis is liable to recur and become chronic, leading to changes affecting both lungs and heart, which occasion prolonged bad health, and ultimately terminate life. More deaths occur in this country from bronchitis than from any one disease, and bronchitis, bear in mind, usually begins by a simple cold. But again, a cold may attack the lungs themselves and produce inflammation in them, or acute pneumonia, or, as it is now often but erroneously termed, congestion of the lungs. The effect is to produce a hardening or solidifying of their natural spongy texture, and to cause great embarrassment of breathing. This is always a serious malady, but if uncomplicated and in a previously healthy and temperate person, usually runs a favourable course. Then, either along with pneumonia, or apart from it, the outer covering of the lung—the pleura—is often excited to inflammation by cold and damp, and that painful complaint pleurisy is the result. In severe cases of this disease an effusion of fluid collects outside the lung and compresses it, rendering it unable to expand to admit air in breathing, and unless this fluid be drawn off or otherwise removed by treatment, imperilling life or entailing serious permanent consequences to the lung and function of respiration.

But beyond all those ailments I have named, in importance is the relation of cold to the production of pulmonary consumption. This disease derives, as you know, its melancholy interest from the fact that it marks specially out as its victims those who, having passed out of childhood's dawn, are in "life's gay morn," with its bright future of promise and anticipation, when the very idea of suffering and dying is, and ought to be, as unwelcome as it is unnatural. How often has the fire of Genius been quenched by the rude blast of this Angel of Death, while as yet it was scarce aglow, and all that survived to a sorrowing age were some treasured fragments of a brief life's work—a sad but imperishable witness to greatness, the beginnings only of which could be achieved, and to virtue that had blossomed but to die! Who among us has not lost a friend, or it may, alas! be one dearer to us than friend, by this dire malady. Have we not often known it devastate a family; removing one, and another, and another, till all were gone. Is it not in every sense of the word truly named consumption?

Now that this malady shows a tendency to run in families is admitted on all hands; but such hereditary influence has probably been greatly overrated, for assuredly in large numbers of instances it cannot be established, and in them the disease must be regarded as acquired. It does not now concern us what is the proportion between these two categories. It is sufficient to know that apart altogether from any hereditary predisposition, consumption may show itself in any one,—in the strong, well-built, and hardy, no less than in the feeble, narrow-chested, and ill-developed. It would lead me too far into the field of purely medical discussion were I to bring under notice all the different factors concerned in the production of consumption, but it may be safely affirmed that in a very large proportion of all forms of this disease one of the principal of these is the taking of a cold or a series of colds. The history of many a sad case of this kind is often very much the following:—A young man (the same quite as often happens in the case of a young girl) catches a cold, to which perhaps he is rather liable. He thinks little about it, and it does not give him much trouble, except that he coughs

occasionally, particularly on lying down at night, and on rising in the morning. He does not look very ill, or it may be is even congratulated on looking fresh and ruddy. But the cough still goes on, for weeks, or it may be for months, and he is at length noticed to be getting thinner. His friends, feeling some uneasiness, persuade him, rather against his will, to seek medical advice. Then is brought to light the real state of matters, and it is found that already he is in the grasp of this dread disease. Who so truly as the physician can realise and appreciate the pathetic language of Henry Kirke White, himself a sufferer from it, in addressing this "most fatal of Pandora's train."

"Oft I've beheld thee in the glow of youth,
Hid 'neath the blushing roses which there bloom'd,
And dropt a tear, for then thy cankering tooth
I knew would never stay till, all consum'd,
In the cold vault of death he were entomb'd."

Now it is in the commencing stage of this disease, while as yet it has many of the characters of a common cold, producing a form of inflammation of the lung, that much may be done by treatment to arrest and remove it, and it is unhappily just in this very stage that it is so apt to be disregarded, upon which there follow the too common results in the wasting of the lungs and the break-down of the whole system. I am far from asserting that this disease, consumption, is not amenable to treatment, and even in a sense to cure, in all but its very latest stages, and our resources are far more abundant and more potent for this than they were when Kirke White wrote; but certain it is that the chance for life and for recovery is immensely greater the earlier the set-down cold is recognised and dealt with. I do not wish to dilate upon this painful topic, except to say that it is from this disease, beyond all others, that the admonition comes with solemn emphasis, *Do not neglect a common cold.*

Disorders of many other parts of the body might be easily cited as owing their origin to cold. Many of the more common and some of the most dangerous of the diseases of the digestive organs (stomach, bowels, &c.) are induced by this cause, as well as inflammatory affections of the kidneys. We know too that many

diseases affecting the special senses, such as sight and hearing, are brought about in this way. But there is one class of ailments which of late years has engaged in a very special manner the attention of medical men, viz., diseases of the nervous system, embracing a large number of most important ailments, many of which are traceable more or less directly to the effects of exposure to cold; for as I have stated in a previous part of this lecture, the influence of a low temperature on this portion of the human economy is very marked. Many forms of neuralgia, which cause intense and oft-recurring suffering, are excited by this cause, and may sometimes be completely cured by an alteration in the mode of dress, which affords greater protection to the affected part. Paralysis, too, may be brought about by cold, a not uncommon form being that affecting one side of the face after sitting with it exposed to a draught of cold, which arrests the function of the nerve supplying the muscles of the face, and thus for a time paralyses them. But more serious forms of paralysis may result from cold. Thus I had recently under my charge for a time in the Royal Infirmary a strong young man who had entirely lost the power of both legs by paralysis, which was caused, beyond all manner of doubt, by his having got thoroughly wet, and gone about for hours without having a change of clothing. Other examples of nervous disease connected with exposure to the action of cold might easily be narrated. But time would wholly fail me were this part of the subject to be pursued further; and it does not indeed appear necessary to add more to a catalogue of maladies already both lengthy and grim, to illustrate the point laid down, viz., the possible consequences of a cold. It is altogether rather a sombre subject, and must, I fear, have had a somewhat depressing effect upon my audience; yet it is doubtful whether a regard to honesty in dealing with it could have imparted much brightness to facts which are but too often forced upon the observation of the physician, and which, as here recounted, do not err on the side of overstatement. I trust, however, nobody is the worse for what has been said.

The best and most hopeful part of my subject now remains to be briefly considered, viz., HOW A COLD IS TO BE AVOIDED. This is

the conclusion of the whole matter, or its practical application. Time, however, forbids my dwelling on many points of detail that might profitably have been brought under notice. It would be mere presumption in any one to profess to indicate any specific plan which would infallibly secure against the taking of a cold. As long as humanity and its environments are what they are, colds will never cease from among the diseases of men. All that I or any one else could undertake is to furnish you with some general directions, the observance of which will go far towards diminishing the liability to suffer from this cause. I must at the outset lay down one or two principles which, although they may seem mere truisms, are, I venture to think, not always fully borne in mind, or given effect to. The first is, that health, to be preserved, must be looked after ; and that not only when it threatens to give way, but when it is at its best, in fact at all times. No man can expect his business to thrive unless he attends to it systematically, and just as little has any man or woman a right to expect the business of their health to thrive unless they give it their attention. I do not say *all* their attention—that is valetudinarianism, and is either a disease or a sin—but their systematic attention, which is a very different thing. This is not difficult of accomplishment, and falls easily in with the general habits of life. Nevertheless there are few of us who do not err in this matter. We complain that these bodies of ours occasion us many of the sorest troubles and burdens of life, but how much fewer of both might there be were we kinder to them than we are—were we indeed only to give them fair play. It is truly surprising how long-suffering they are, and how often it is only after prolonged neglect and outrage that they, as it were, turn upon us and take a severe but not unmerited revenge. That the domain of Christian duty includes the care and the honouring of the body admits of no dispute.

If these remarks be true as regards health generally, how much more are they applicable in reference to those particular points of it which, from our surroundings, are pressed upon our attention, such for example as the influence upon us of a changeable, and often cold and ungenial, atmosphere. How necessary is it to be

protected and armed at every assailable part, and how inevitably must laxity in this matter sooner or later bring its own punishment. I have told you how our bodily heat is generated by changes taking place within us in the processes of nutrition, and how necessary it is that this function be maintained in integrity if we are to escape the evil effects of cold acting on us from without. We must keep this internal fire burning by supplying it with coals, that is with food, and the supply should be regular and of good quality. Don't let it get low by too long fasts, and don't put rubbish in it which will not give any heat. Our food, as previous lecturers have shewn you, must contain a due proportion of the albuminous elements, and of the carbo-hydrates (starch, sugar, and fat). Both are necessary to the heat-generating process. Everyone knows how vigorously we can set ourselves to face a cold wind, when, with a healthy appetite, we have taken a wholesome meal, and if our meal be wholesome, in accordance with the principles I have just indicated, we need nothing more. This leads me to say a word on the effect of alcoholic stimulants as means for resisting cold. The popular idea, and too prevalent practice, of taking a glass of spirits to keep out the cold is a great and dangerous delusion. It does the very reverse. The immediate effect no doubt is to impart a sort of warm glow and exhilaration, but this is a feeling and not a reality. The nervous system is abnormally stimulated, and the action of the heart excited, but these are speedily followed by depression. Again the bloodvessels of the skin are fuller of blood, and in consequence more heat is radiated away from the surface, while the contractile power already referred to as residing in the skin is also impaired, and in these various ways cold is able to exert its hurtful action, while the means for resisting it are greatly lessened by the alcohol.

In this matter the experience of Arctic voyagers and others who have had the opportunity of fully testing it is in entire agreement with the teachings of physiology. Dr Hayes, the celebrated American Arctic explorer, declared that alcohol taken for the purpose of resisting cold was "not only completely useless, but positively injurious;" while the experience of the officers who

accompanied the Red River Expedition, under Sir Garnet Wolseley in 1870, was that while the troops had as arduous work to perform as ever fell to the lot of British soldiers, they continued throughout in excellent health although not a drop of drink was given, the only beverage being tea. Numerous other instances of a like kind could be cited did time permit. Depend upon it, then, that the man who by a single glass of spirits places himself under the influence of alcohol—in a scientific, if not in a conventional sense—is far more liable to suffer from cold than he who has fortified himself simply by sufficient and suitable food. In cold weather the food should be greater in quantity than at other times—this is indicated by our increased appetites—but it should likewise have more fatty matter contained in it, to promote the heat-making process within us. This is especially necessary in the case of the young and the delicate as a means, and a very valuable one, for resisting the action of external cold. Such articles of food as cocoa, milk, bread and butter, may be taken by most persons, even by those who cannot, or will not, eat meat containing fat. The value of a daily small dose of cod liver oil for those, whether young or old, who shew a liability to suffer from colds is very marked. This substance is a food as well as a medicine, and possesses properties which render it easy of digestion, if rightly administered as to time and quantity. It should be taken either after a meal, or near bedtime—probably the latter answers best on the whole; while the quantity need not be large, a single teaspoonful or little more being quite enough. Many a cold, and many a serious and fatal illness might be averted were this practice carried out systematically during a winter, particularly among children.

Attention to the skin is of the very first importance as a measure for enabling us to withstand the injurious effects of cold. It is, as has been already stated, chiefly by the skin that we catch a cold, and it is certainly by the skin that we may most successfully prevent a cold. The relation of the skin to the general health has been amply demonstrated to you in a previous lecture, and I can say nothing to emphasize the wholesome lessons therein conveyed. It is with the care of the skin in connection with the

catching of a cold that we have at present to do, and there are two aspects in which this subject is to be considered. The one is the maintenance in its vigour of the function of the skin, and the other the due covering and protection of the skin. As to the first, bear in mind the facts already brought before you in reference to the structure of the skin, and to its various functions; how it is to be regarded not merely as a covering for the body, but as an organ of the body, consisting of fibrous tissue, cells, glands for sweat and oil, also innumerable bloodvessels and nerves; and possessing in addition to the property of carrying off effete matter, the power of regulating to a large extent the bodily heat. To fulfil all these important offices aright it must not only be unclogged of the matters that are apt to accumulate on it, that is, dirt, and kept thoroughly clean, but also be preserved in a state of good tone, and readiness to act, as we know it is often called upon to act, suddenly, on its defence and the defence of the system generally, when subjected to the assault of cold air. The regular practice of washing and bathing are essential for both of these purposes. It might seem almost impertinent for me to advocate the obvious and natural duty of washing and cleansing the skin, but frequent medical examination of the persons of individuals, particularly in hospital practice, too often reveals a state of things which shews that this advice is not by any means uncalled for. There seems to be a tendency—there is no doubt a temptation—to limit the ablutionary efforts to those parts that are exposed to view, while Nature is compounded with on very easy terms indeed for the rest, to the manifest injury of the health, no less than to the disgust of the unfortunate medical examiner. I say to the injury of health, for if you will recall what was stated as to the number of pores on the surface of the body (about 2,300,000), you will easily understand that if the most of these are closed up by dirt, the whole system must suffer, and the skin itself be enfeebled in function, and less resistant to cold. But in addition to the purposes of cleansing the skin, washing and bathing the body are very important as tonics for the skin, that is, for keeping it in vigorous operation. The genial glow

and pleasurable lightness both of body and mind which follow the cold bath and brisk rub down with a rough towel, would be recompense enough for the effort of self-denial or compulsion, which, on a cold morning, has to be put forth in undertaking it; but there is far more in it than this. For this plan of treatment of the skin, if systematically carried out, induces a healthy action in each single part of its structure—cells, fibres, nerves, vessels, &c., and confers on the whole a vigour of tone which, if it does not afford complete immunity from catching a cold, goes far towards it, since the surface is seldom surprised by any sudden change of temperature, and reacts powerfully when it is. The bath should, if possible, be of cold water, but no absolute rule should be laid down on this point, much depending on the power of reaction, and the presence or absence of the feeling of glow which follows it. There are some persons to whom the cold bath is intolerable, some to whom it is positively dangerous. Very young children, delicate persons, and those advanced in life, should not as a rule have the bath cold, at all events in winter, but the temperature of the water should be raised so that shock may be avoided. In any case, the subsequent thorough rubbing with a rough towel is of scarcely inferior importance to the bath itself. There can be little doubt that were the bath with friction of the skin regularly employed by those up in years—and the habit, if acquired, can be easily carried on—much suffering and disablement from bronchitis or winter coughs might be avoided, as well as many of those troublesome forms of skin disease so often met with. As a means for preventing colds the bath is only of use if employed frequently, daily if that can be, if not, then as often as possible, and with regularity. We are all too well aware that the carrying out of this practice in a large proportion of our smaller houses is in great measure prevented by the absence of the means, viz., the bath, and even the most zealous in this cause has often to be content with an unsatisfactory substitute in the shape of a daily rub down with a wet towel or sponge. The obvious remedy for this, and a most desirable sanitary measure, is the establishment of public baths on a sufficiently large scale. It was a welcome announcement which was

made here the other night by the Convener of the Health Committee of the Town Council, viz., that this matter was engaging the attention of that Committee, and of the Medical Officer of Health for the City, and we may be sure that in such energetic hands it will not be allowed to rest. Such a public blessing cannot come a day too soon—as blessing I feel sure it would be regarded by the working people of Edinburgh.

The next point as regards the skin is its covering. Our skin, however healthy, must be protected by clothing, which will prevent the too great access of external cold on the one hand, and the too abundant radiation of heat from the surface of the body on the other—in short, which will keep out the cold, and keep in the heat; and such clothing, therefore, particularly that portion of it investing the skin, should be made of comparatively non-conducting material, such as wool, which is infinitely the best for this purpose. The utility of flannel underclothing is generally recognised, although there are not a few individuals in all classes of the community who affect to despise such measures of precaution, under the notion that they keep themselves hardier by avoiding them, and many persons, no doubt, do avoid them with impunity. But in a climate like ours, with its extraordinary changeableness and extensive prevalence of damp and cold, this cannot be done without serious risk even by the most robust. The neglect of flannel for young children is little short of criminal, when we consider how extremely susceptible their respiratory organs are to inflammation brought on by cold. It is impossible to believe that that appalling mortality from bronchitis in children under three years of age to which I have referred, would have been anything like so great had every one of these infants been properly clothed, fed, and cared for. The irritation produced in some by flannel induces them to wear it over a cotton or linen garment in immediate contact with the skin, which of course is better than no underclothing at all, but such irritation is in most instances entirely got rid of after a time, and should it not, then some softer material, such as merino, might be tried. Chamois and other skins, though pleasant, are not so healthy. The underclothing, if of suitable material, need not be very thick,

for this is apt to oppress us when we sit in a warm room, or when the weather takes a mild turn. The flannel should come high up on the chest, a point much neglected by women, who often suffer from their having a large portion of a locality of the body most susceptible to cold comparatively uncovered. The so-called 'chest protectors' worn by many delicate persons, if made of flannel and adapted to the back as well as front of the chest, are likely to be a defence against the catching of a cold. The expense connected with obtaining good underclothing will certainly repay itself and is the soundest economy in the end. The upper clothing should also be of good cold-resisting material, but if the underclothing be ample as to amount and quality, no great advantage results from heavy outer garments. Thick top coats, except for very severe weather, are often a great burden, and to those who are much in the open air, an upper coat of not too thick material is better. Weight by no means implies warmth. Thus in one of the industrial schools in town with which I am connected, the infant children as well as the elder ones were attired in suits of that hard and unkindly material called moleskin, which simply hung upon them and weighed them down, affording very little warmth. A change was made to tweed, and the result was soon apparent in the comparative absence of colds, chilblains, and other winter troubles, which had been before so common.

As to female attire, much might be said did time permit, but only a general remark or two can be made. Even to one possessing so little technical information on these matters as myself, it seems possible to discern in their management of late years the presence of more rational principles, and to find that the dictates of health are to some extent, at least, contesting the sway of imperious Fashion. Nevertheless, it cannot be denied that many of the modern modes of females' dress are not conducive to the maintenance of a robust body—a fact of momentous importance when viewed in relation to the well-being of future generations. There is reason to fear that much infantile delicacy and infantile mortality are directly the result of present or past inattention to their own health on the part of mothers. The tight waists, and tight and thin coverings for the hands and feet, operate

powerfully in producing colds and their effects, since they interfere with the healthy circulation of the blood in the skin, and reduce its resisting power. The frequent neglect of flannel, or its partial and inadequate employment, have a like effect. Rely upon it, that the more sound sense, enlightened by a knowledge of the laws of health, prevail in regulating the manner of woman's attire, although there may be some figures less gainly, and some hands and feet a trifle larger than their owners would like, the grand result would be lives saved, suffering averted, a large increase in the presence among us of typical female humanity, and greater aptitude and power for fulfilling the noble part in the world of her sex. The dress of children, particularly girls, is also open to many objections, and is only defensible on the condition that ample warm underclothing is worn. Every other means calculated to promote the invigoration of the system will to that extent enable us to avoid a cold. Regular outdoor exercise, regular meals, regular hours, early rising, and sea-bathing in summer, are all helpful to this. Means for strengthening those parts most liable to suffer from a cold, such as the respiratory organs, should not be neglected, particularly among the young: moderate gymnastic exercise, skipping ropes, chest expanders, dumb-bells, etc., but especially the practice of singing, which assuredly tends to the nutrition of the lungs, and the development of the chest. It is pleasing to think that the teaching of singing is now so general in our schools, as its bearing upon the promotion of the health is most important; but it should be practised at home as well as in school, and by grown people as well as by children, provided, of course, they are in good health. I cannot help thinking that if there were more singing there would be less coughing.

A word to those who are susceptible to colds. To avoid them more than the ordinary precautions already dwelt upon require to be taken. Keeping the extremities, especially the feet, warm is of great consequence, and for this purpose, besides warm stockings and stout boots or shoes, an inner sole of felt, flannel, or cork is useful. They should, when in the open air, endeavour to keep moving, and they should breathe, as they were intended

to breathe, by the nose and not by the mouth. When out in cold winds the neck should be covered by a muffler or cravat, which need not be thick, but sufficient to protect the skin from chill in that locality, which appears to be a frequent manner of our catching cold. Indoors equal care is necessary to avoid draughts and cold rooms. I am no advocate for fires in bed-rooms, but they are sometimes necessary when the room is large, and there is a tendency to cough after lying down and during the night. The practice of sleeping with an open window in winter is not safe, at all events in the case of the delicate or the very young. Colds may be caught in bed, and therefore there should be ample covering to the body by bedclothes, and by night-dress, which in children should be long and of woollen material. When there is a liability to frequent sore throats, a regular night and morning gargling with cold water all the year through will avail much.

Perambulators are now so thoroughly an institution of our day for the locomotion of young children that it would be vain to attempt to discountenance them. In winter, however, they are often the cause of their occupants catching colds, when used in biting winds, or when allowed to stand while those in charge of them are enjoying a talk with a friend, or when the body and limbs of the child are not abundantly wrapped up.

Lastly, let me say that when we feel ourselves chilled and tending to shiver, we should try to put forth a strong effort of the will to resist the feeling, for much evil I am persuaded may often be warded off in this way. If, in addition, we can promptly have recourse to a hot bath for the whole body, and a hot drink—tea, coffee, gruel, etc., are better than alcohol—a cold which might otherwise produce serious results may often be extinguished at the onset. This, however, leads me to the confines of my subject, and to pursue it further would be, as the lawyers say, "travelling beyond the record," for you will observe my lecture did not include the treatment of a cold. This may, perhaps, form a subject for future discussion, for the whole topic is one that is much too large for a single lecture, and I have had to deal

with it in a very sketchy manner. If, however, anything which has to-night been brought under your notice should produce in any of my audience a higher sense of the value of possessing, and the duty of conserving, the God-given blessing of health ; or if it should be the means, in any measure, of preventing the evil consequences which we have seen are apt to arise from the hurtful action of cold upon our bodies ; above all, if it should be instrumental in saving a single life—even the life of a little child, great indeed would be my satisfaction and thankfulness.



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ALFRED HAVILAND, M.R.C.S.,

*Medical Officer of Health to the Northamptonshire
Combination of Sanitary Authorities.”*

(See Report to a meeting of the said authority, Northampton Papers, December 7, 1878).

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NEW and IMPORTANT Features adopted by the Company.

1. Forfeiture from omission to pay the Premium abolished by applying the Surrender Value to keep the Policy in force. Paid-up Policies granted.
2. LOW RATES of Premium with very large ultimate Bonuses ; and STILL LOWER Rates, with Bonuses applied to extinguish the later Premiums.
3. Option of applying the Bonus to make the Policy payable during lifetime.
4. Fixed Surrender Values of liberal amount.
5. Freedom from Extra Premium for Foreign Residence from the outset, or after five years.

FIRE DEPARTMENT.—Insurances against loss by Fire are granted on the most favourable terms, combined with unsurpassed security, the proportionate amount of Fire Guarantee and Reserve Funds as compared with the Premium Income being greatly larger than in the case of most other offices.

D. DEUCHAR, *Manager.*

January 1882.

